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(12) **United States Patent**
Mast et al.

(10) **Patent No.: US 10,076,320 B2**
(45) **Date of Patent: Sep. 18, 2018**

(54) **LATERAL RETRACTOR SYSTEM AND METHODS OF USE**

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(21) Appl. No.: **15/680,744**

(22) Filed: **Aug. 18, 2017**

(65) **Prior Publication Data**

US 2017/0340318 A1 Nov. 30, 2017

Related U.S. Application Data

(63) Continuation of application No. 15/372,426, filed on Dec. 8, 2016, now Pat. No. 9,826,966, which is a (Continued)

(51) **Int. Cl.**
A61B 1/32 (2006.01)
A61B 17/02 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/0206*** (2013.01); ***A61B 17/025*** (2013.01); *A61B 2017/0256* (2013.01)

(58) **Field of Classification Search**
CPC A61B 1/313; A61B 1/3132; A61B 1/3135; A61B 2017/0218; A61B 1/32;
(Continued)

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Primary Examiner — Lynnsy Summitt
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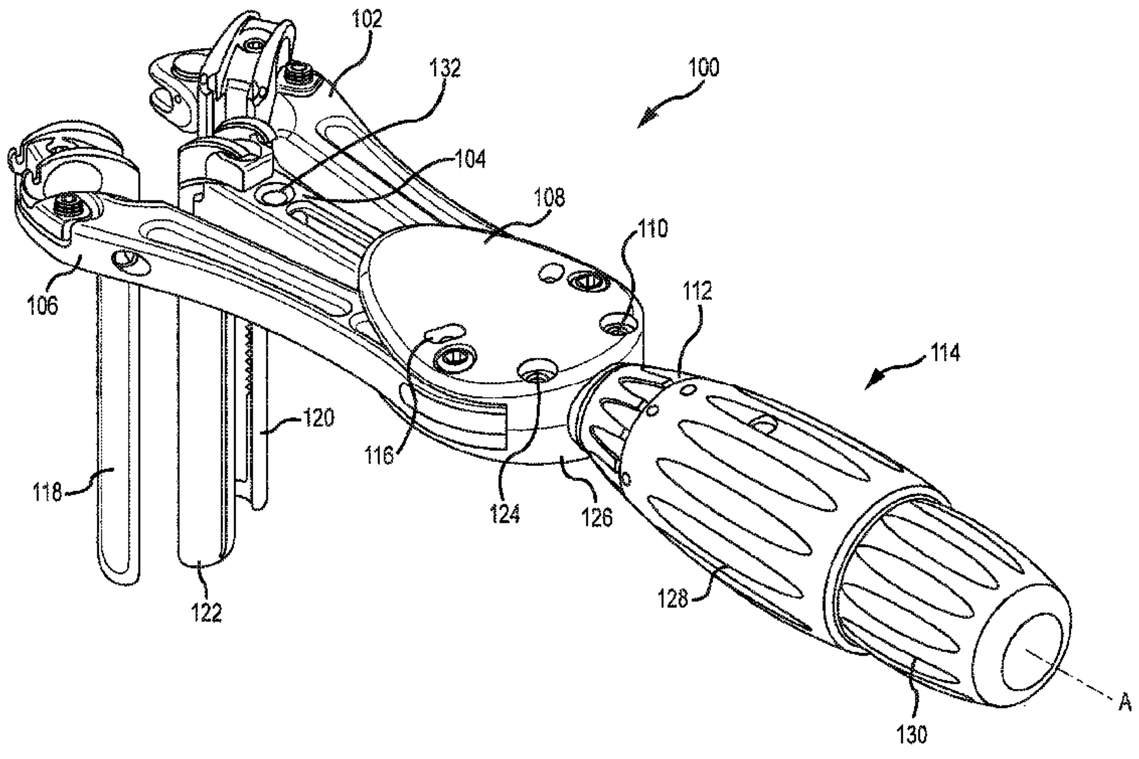
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(57) **ABSTRACT**

Technology disclosed herein relates to retractors and methods of use for surgical procedures, and in particular, spinal surgical procedures. In one embodiment, a surgical retractor includes a pair of pivotable armatures and a translatable armature. A body for supporting the armatures is provided, with a handle connected thereto. The handle includes a first rotary actuator, wherein a rotation of the first rotary actuator moves the pair of pivotable armatures in opposite arcuate directions, and a second rotary actuator, wherein a rotation of the second rotary actuator translates the translatable armature in a linear direction.

13 Claims, 28 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/183,380, filed on Jun. 15, 2016, which is a continuation of application No. 13/601,887, filed on Aug. 31, 2012, now Pat. No. 9,572,560.

(60) Provisional application No. 61/529,756, filed on Aug. 31, 2011.

(58) **Field of Classification Search**
CPC . A61B 17/02; A61B 17/0206; A61B 17/0218; A61B 2017/0237; A61B 17/3439; A61B 17/025; A61B 2017/0256; A61B 17/0293; A61B 17/3423; A61B 17/0281
See application file for complete search history.

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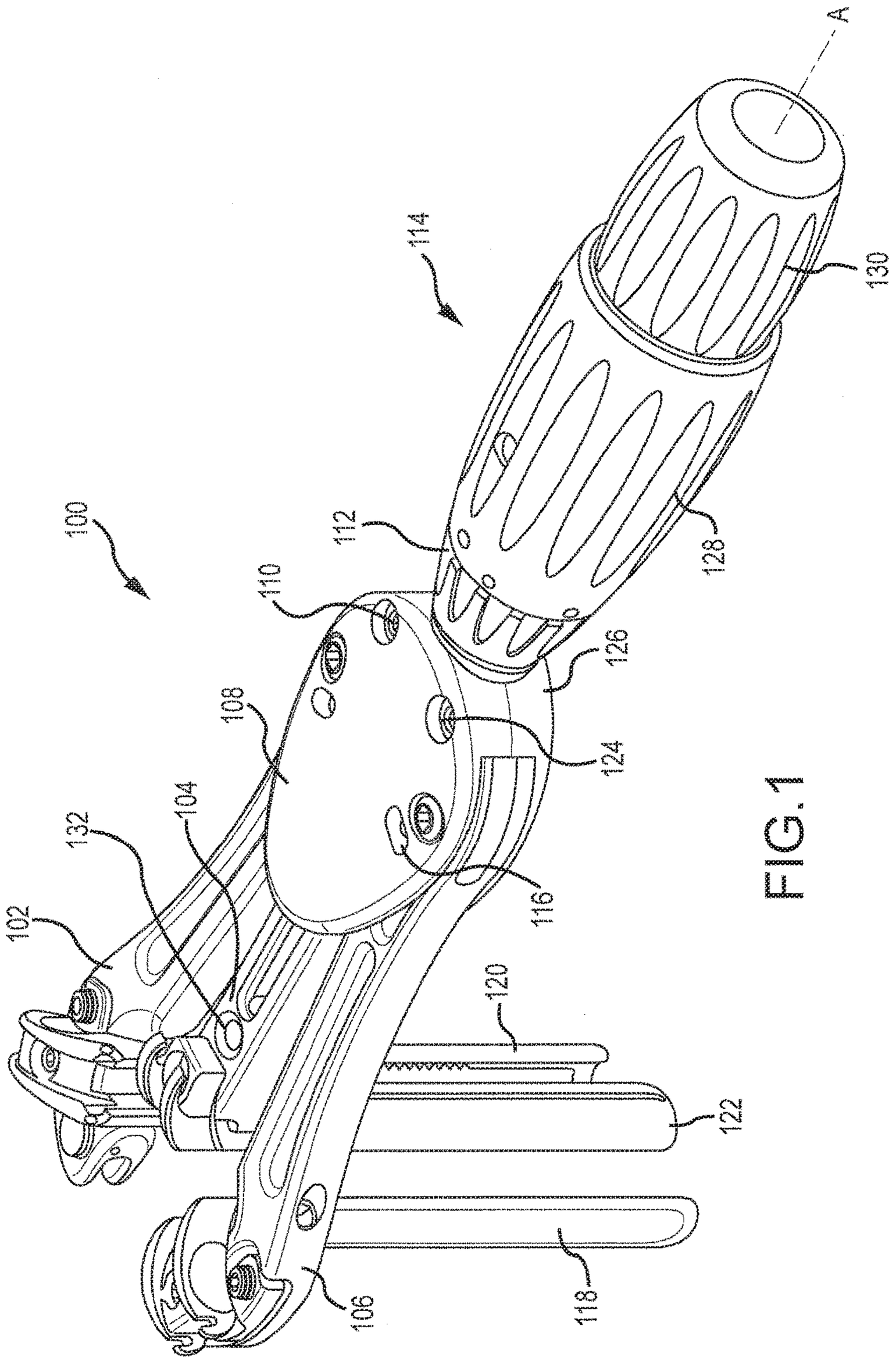
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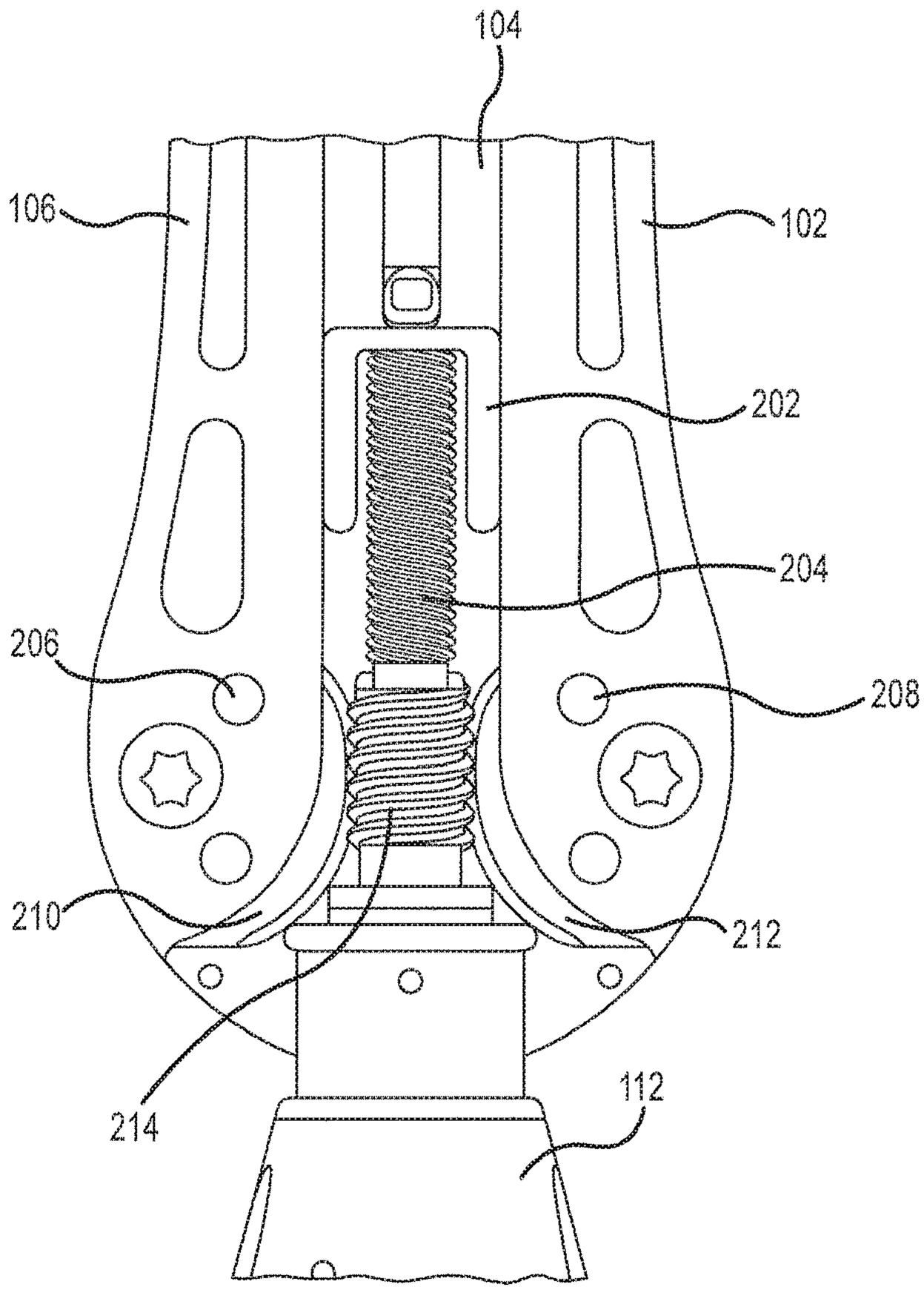
FIG. 1



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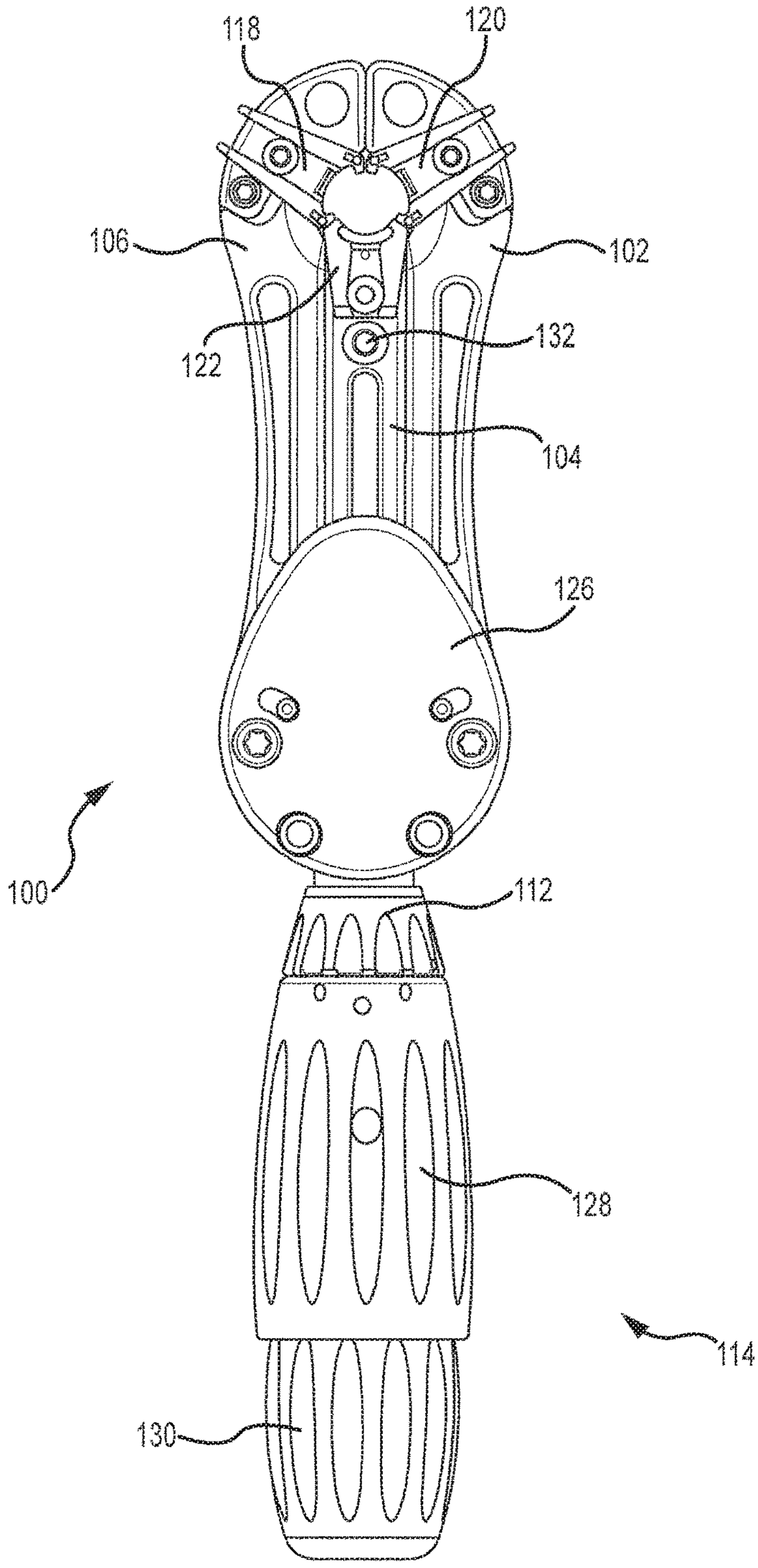


FIG.3A

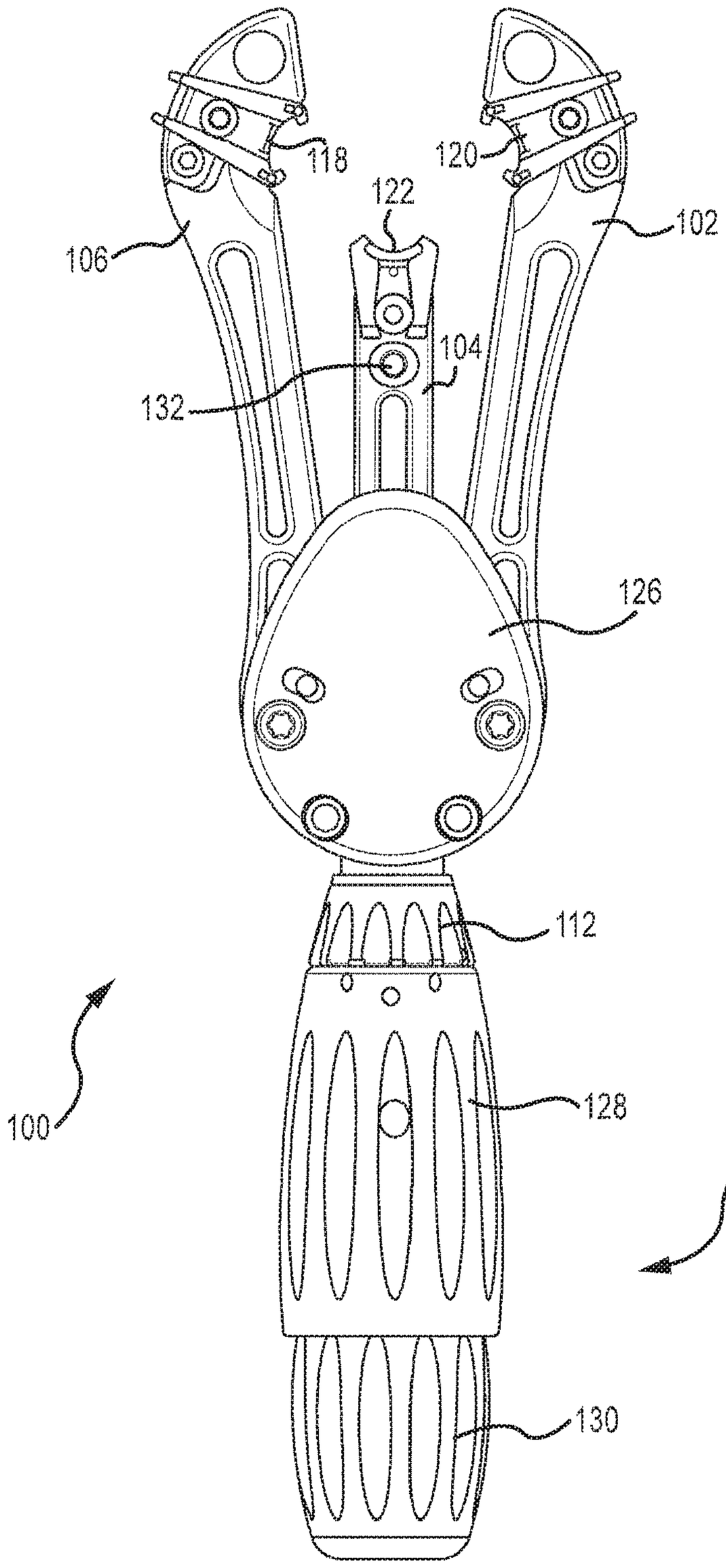


FIG.3B

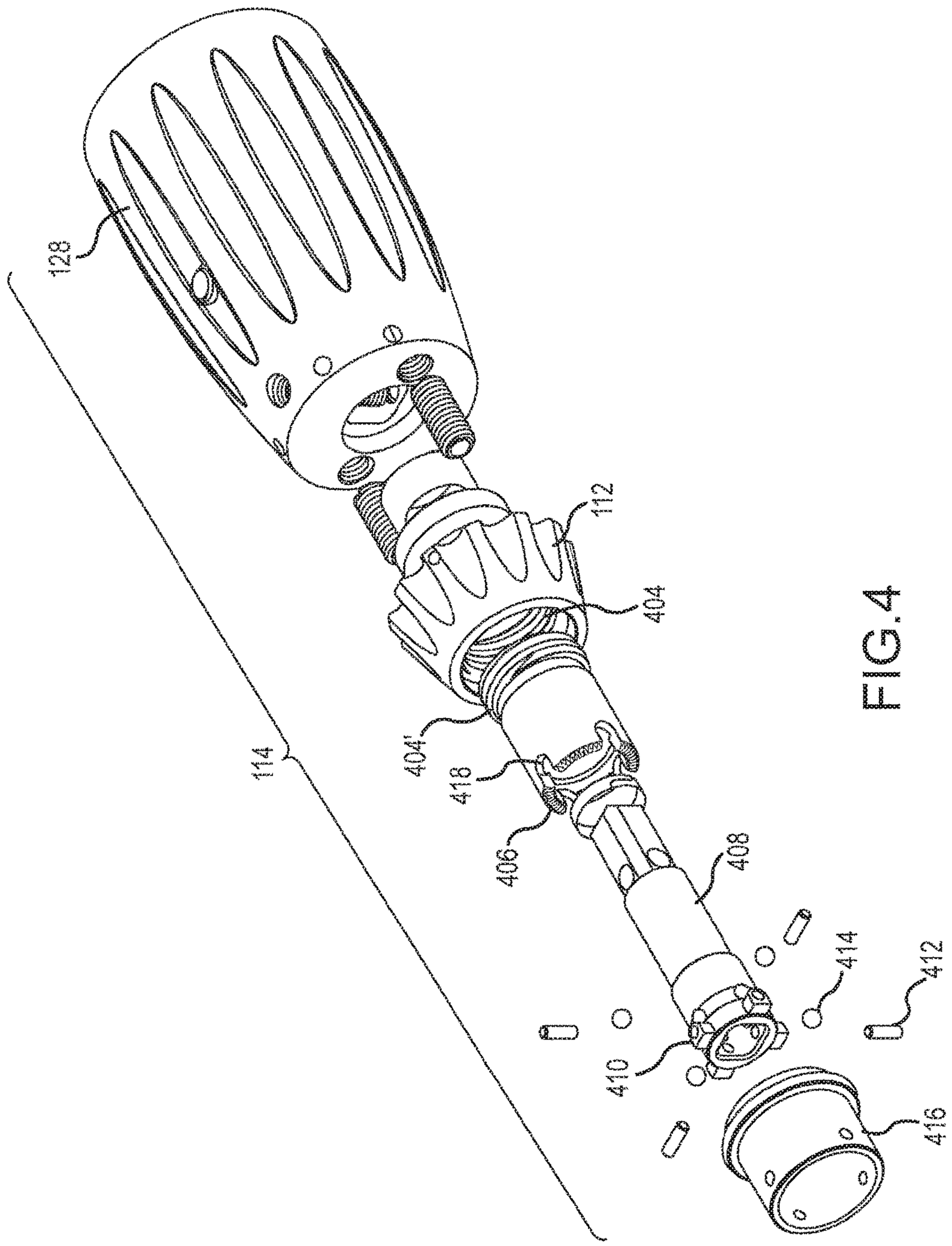


FIG.4

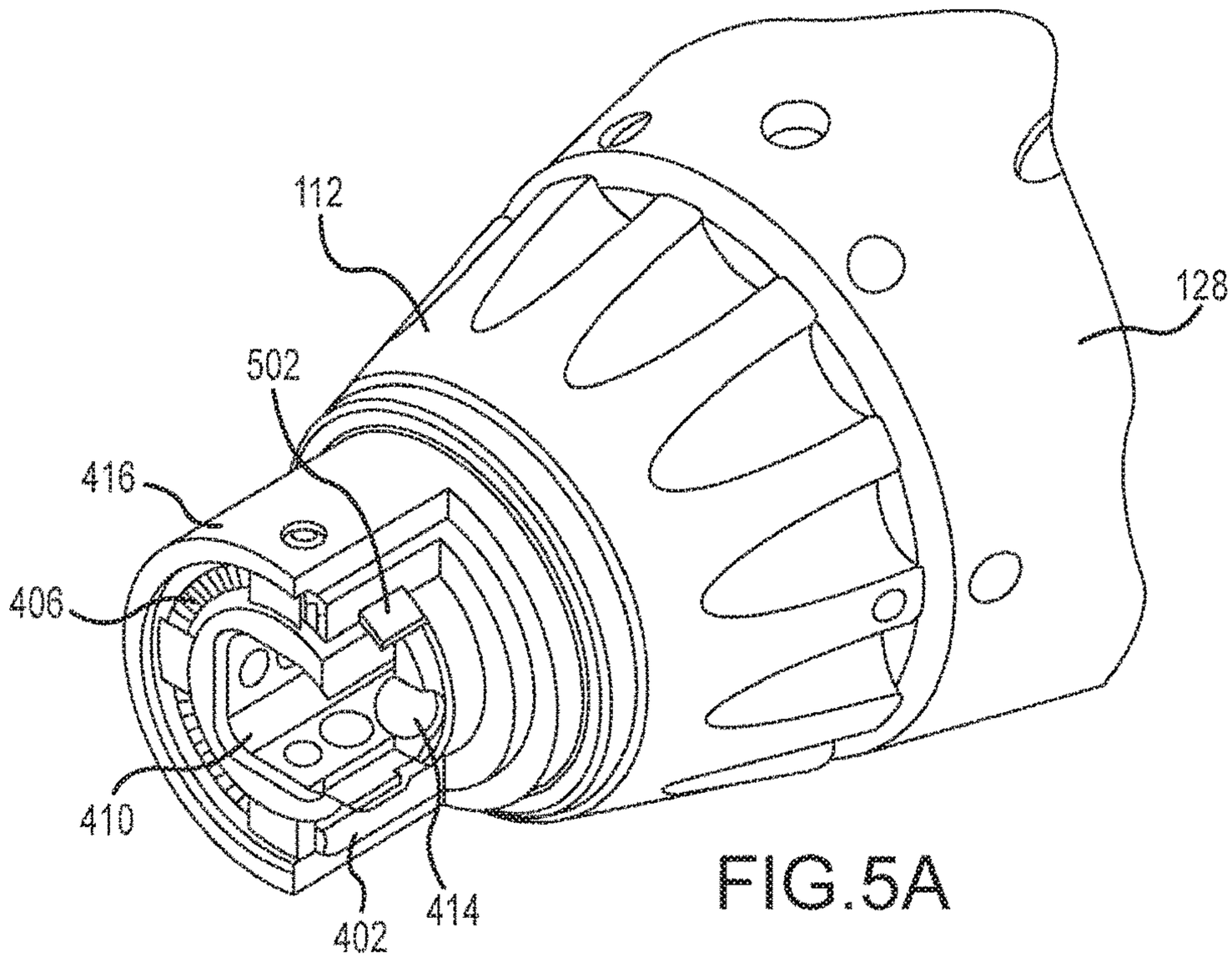


FIG.5A

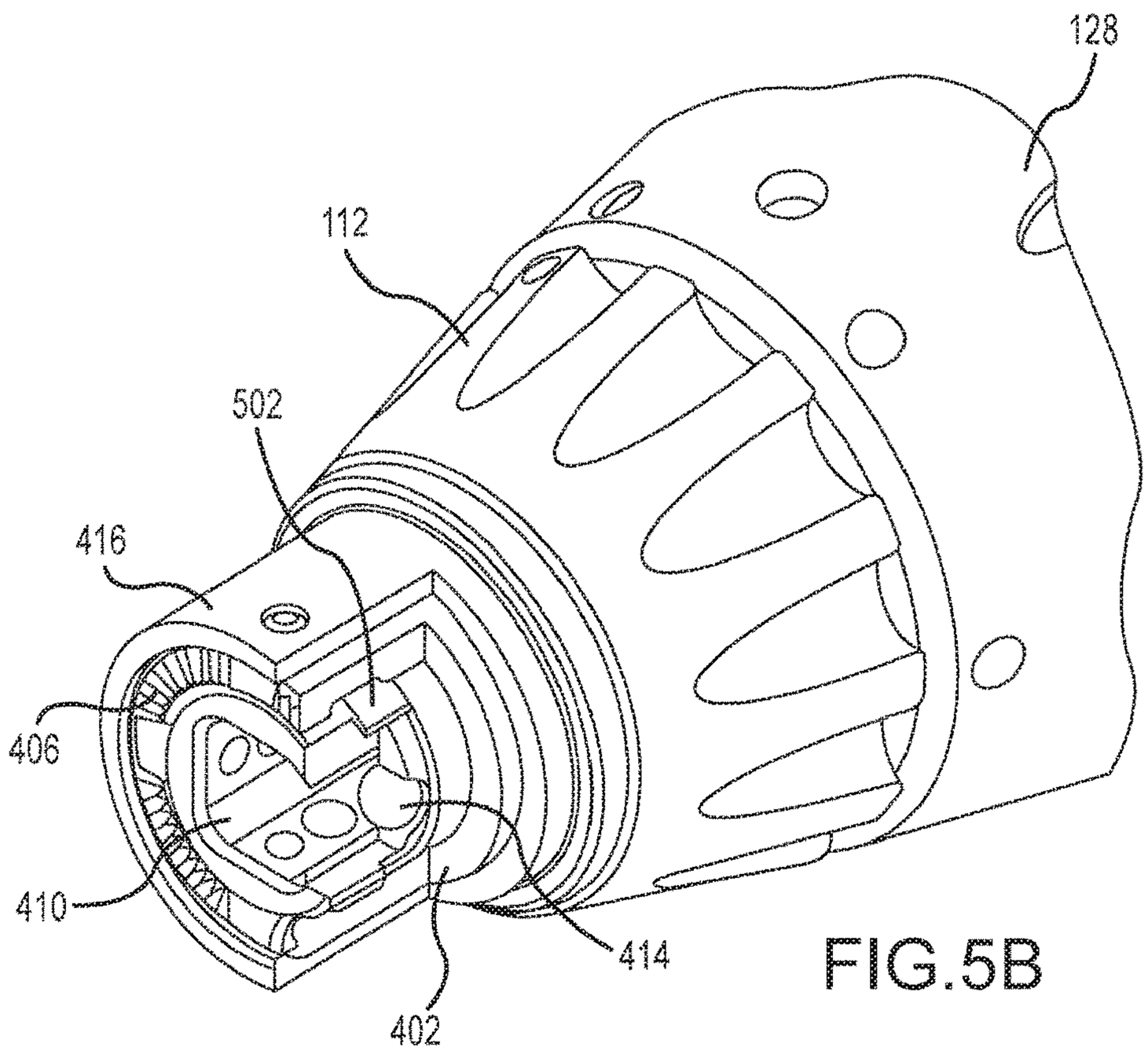


FIG.5B

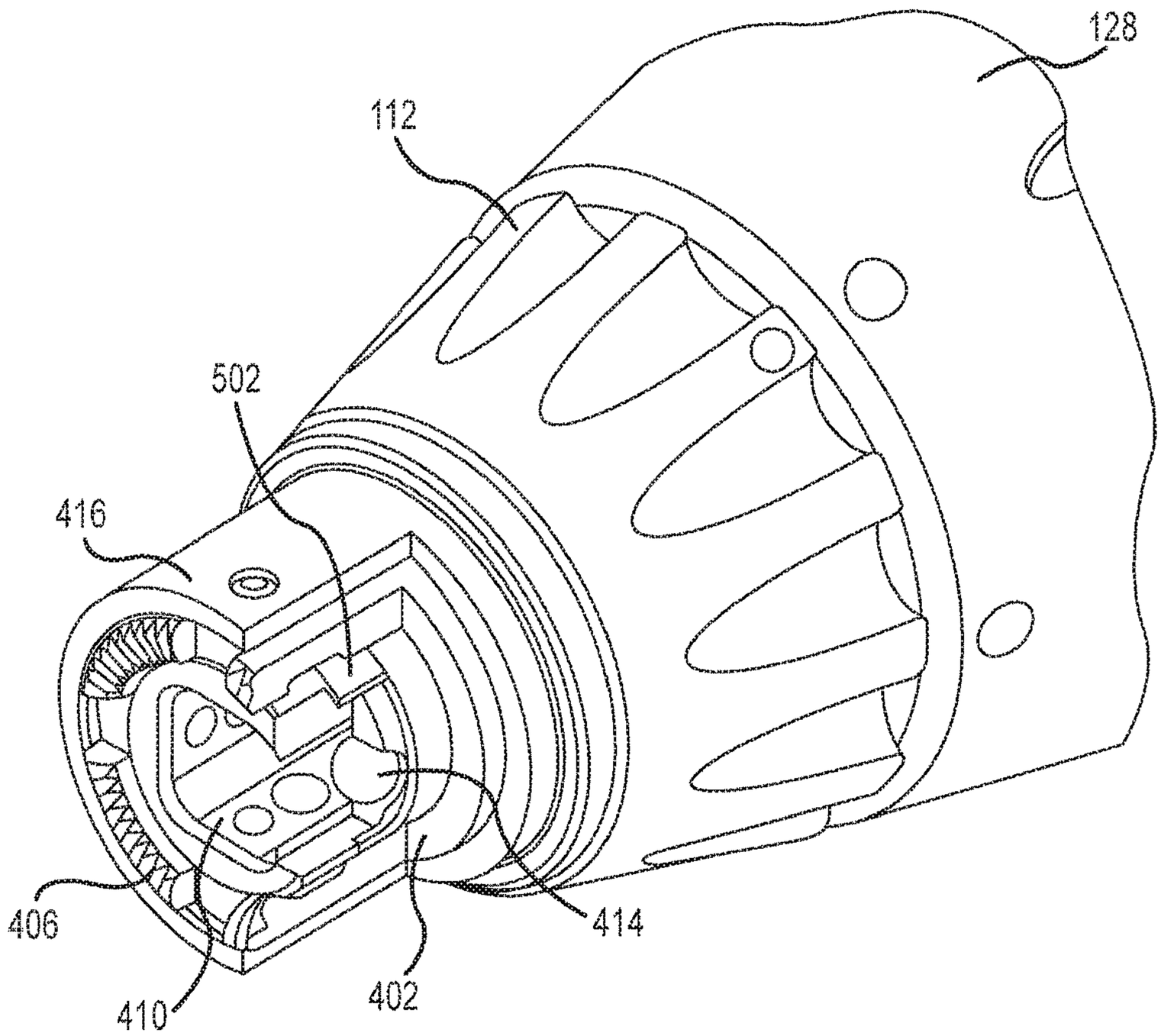


FIG.5C

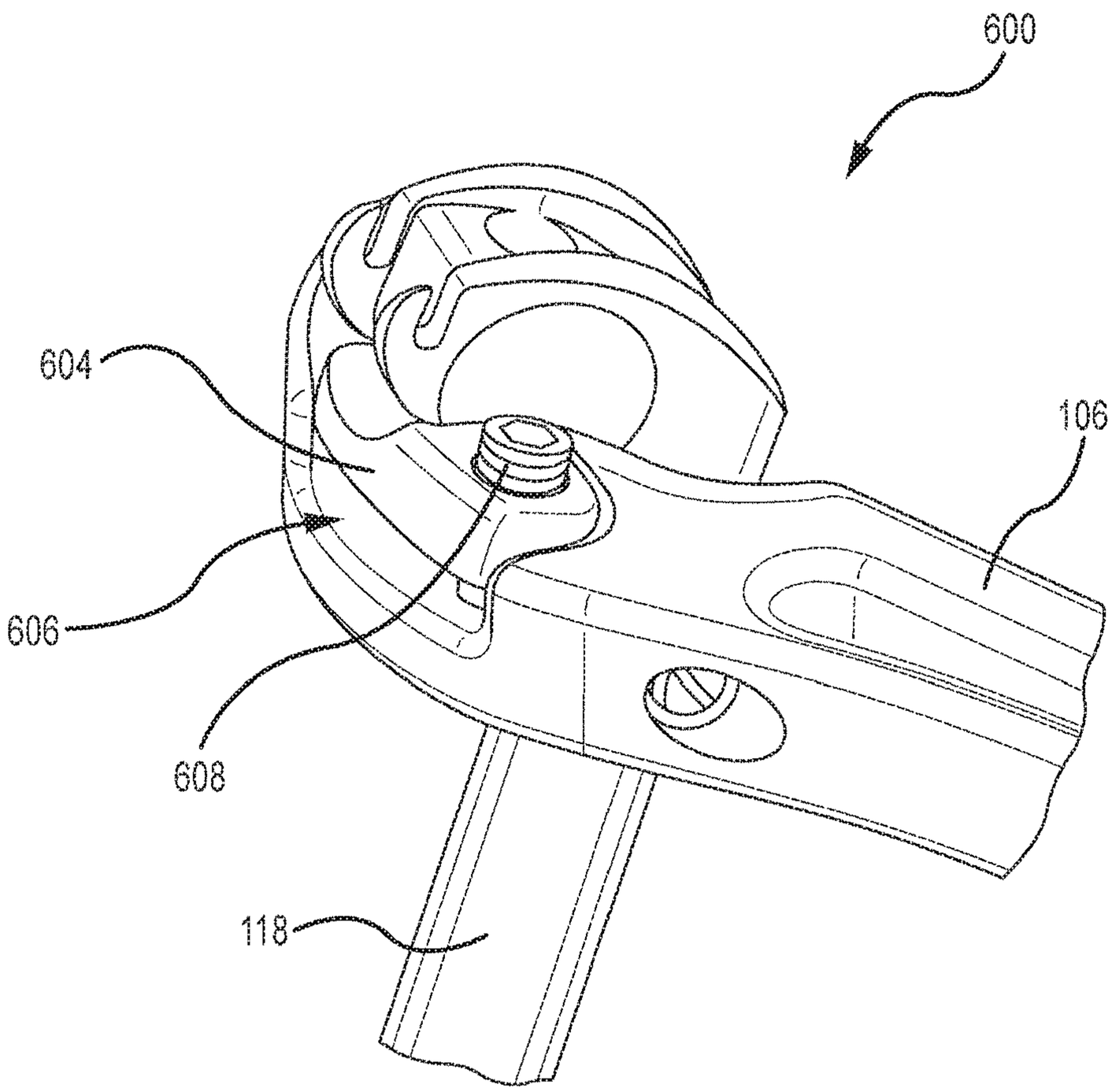


FIG.6A

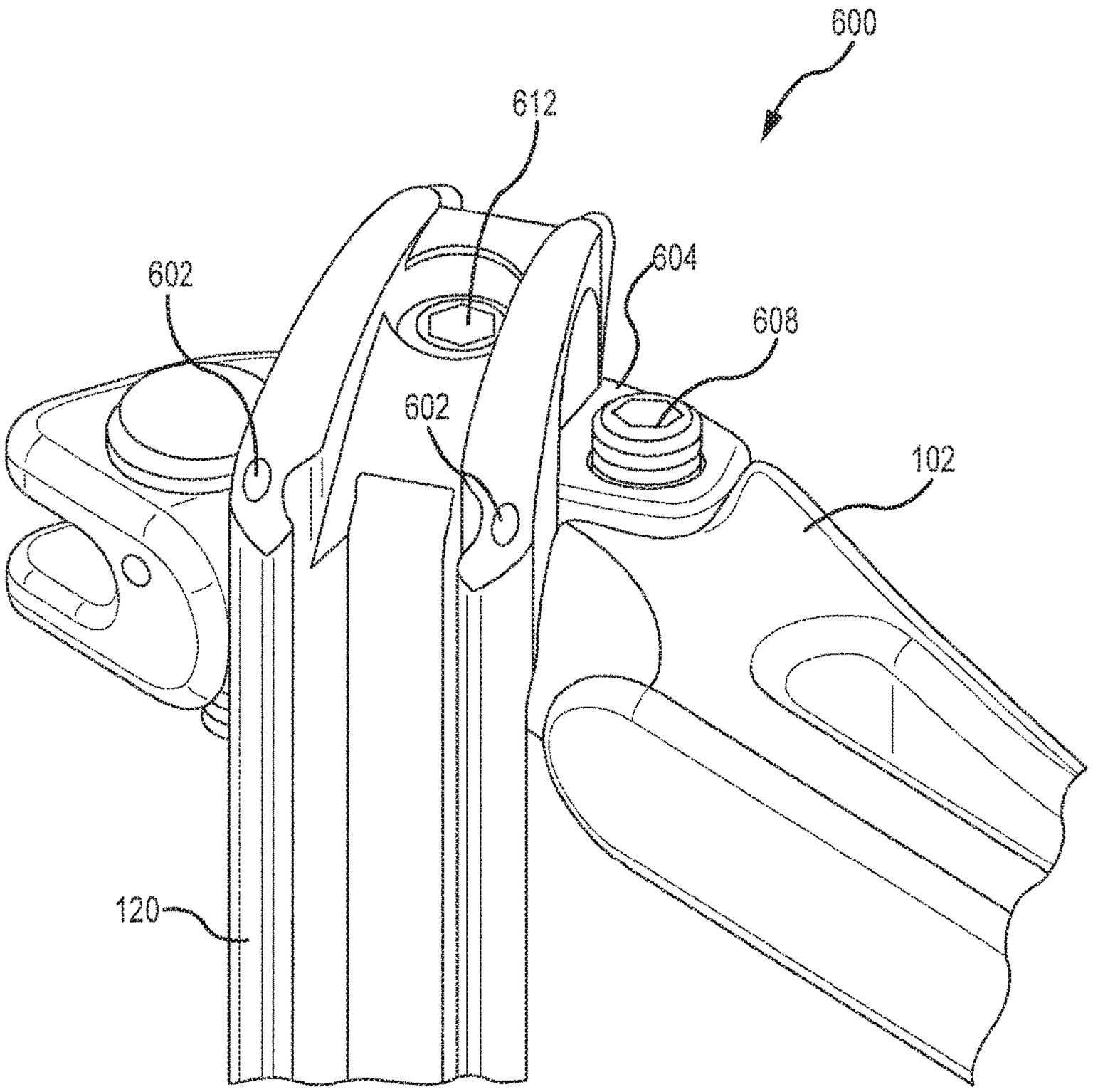


FIG.6B

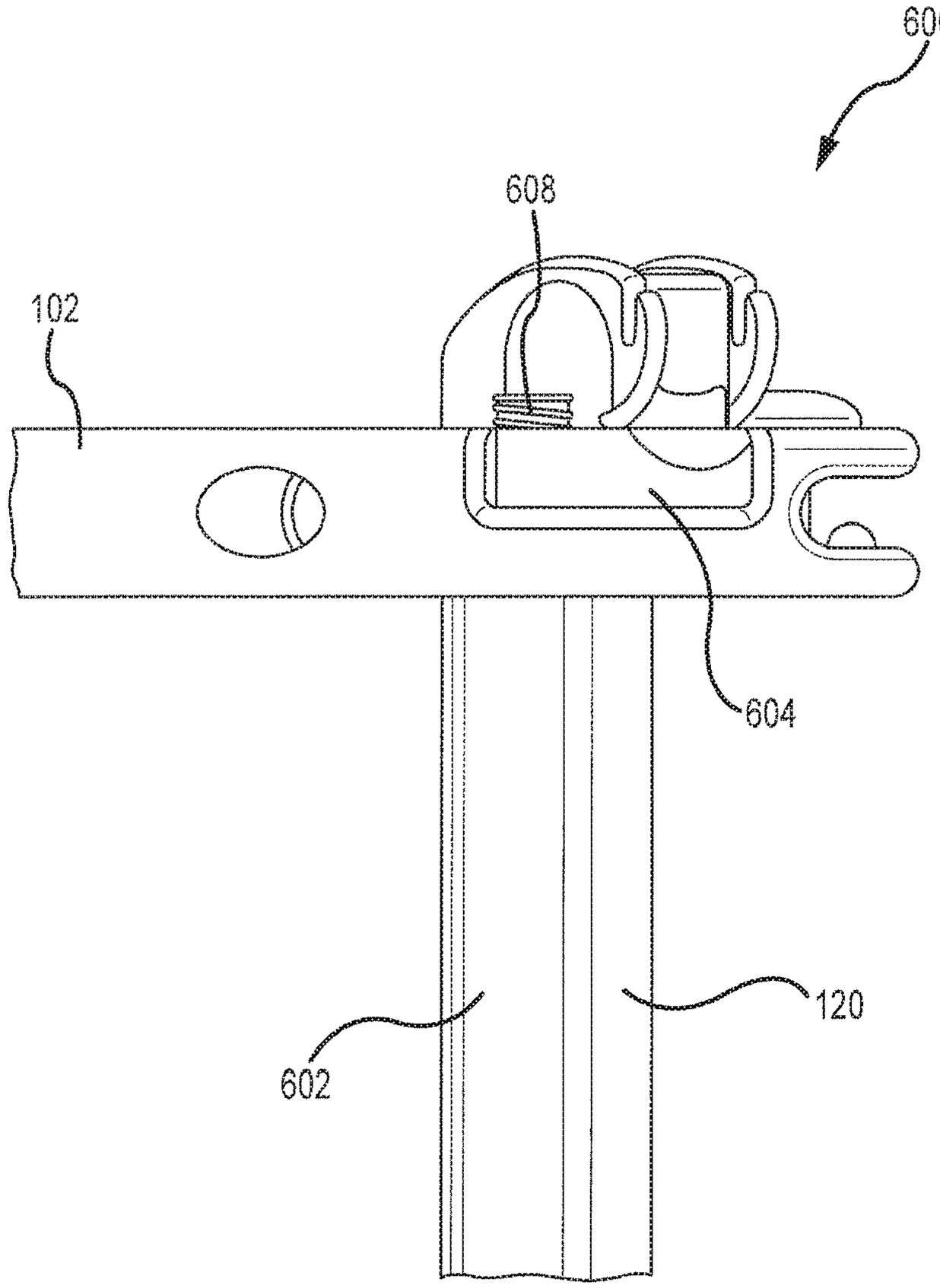
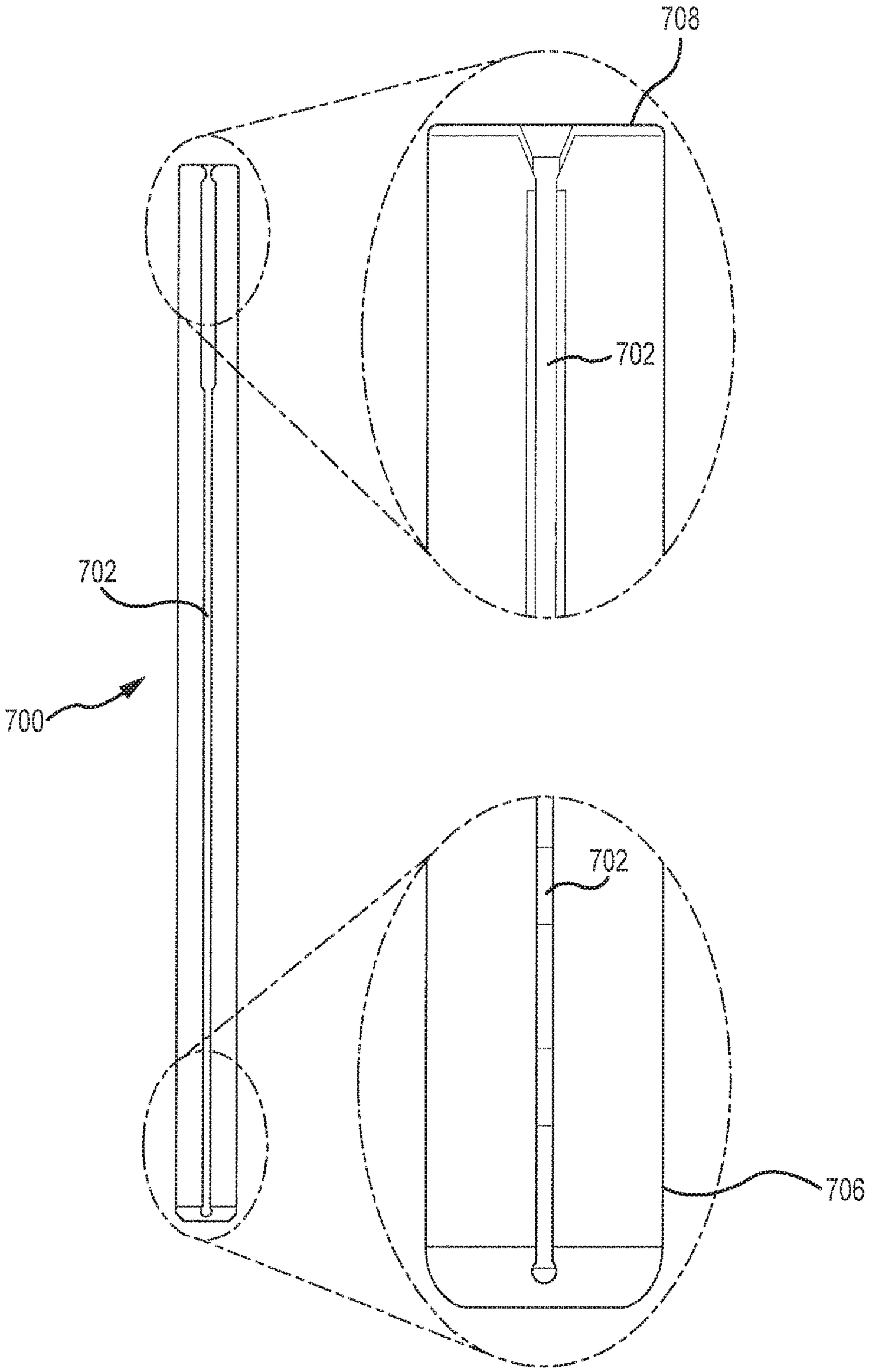


FIG.6C



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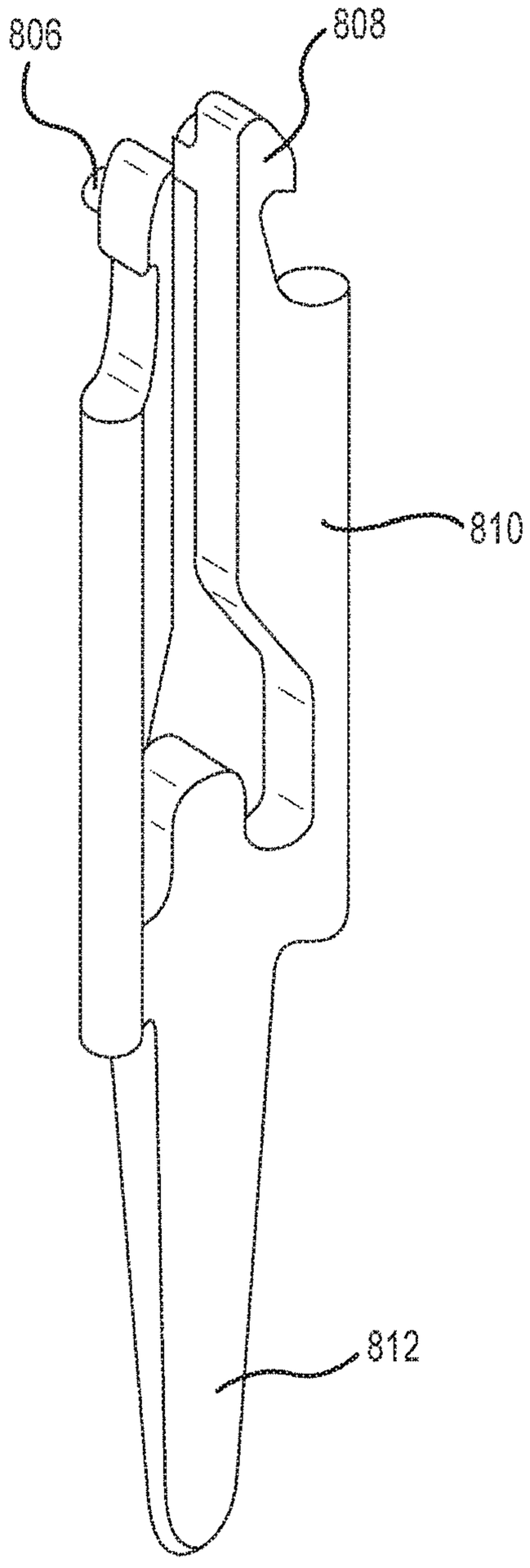
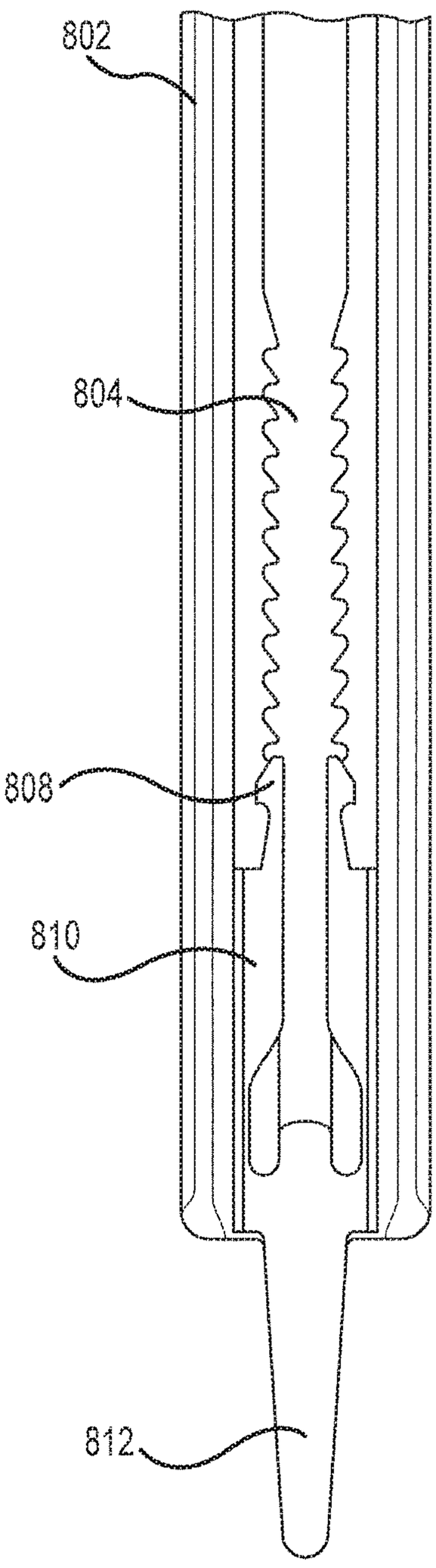


FIG.8A



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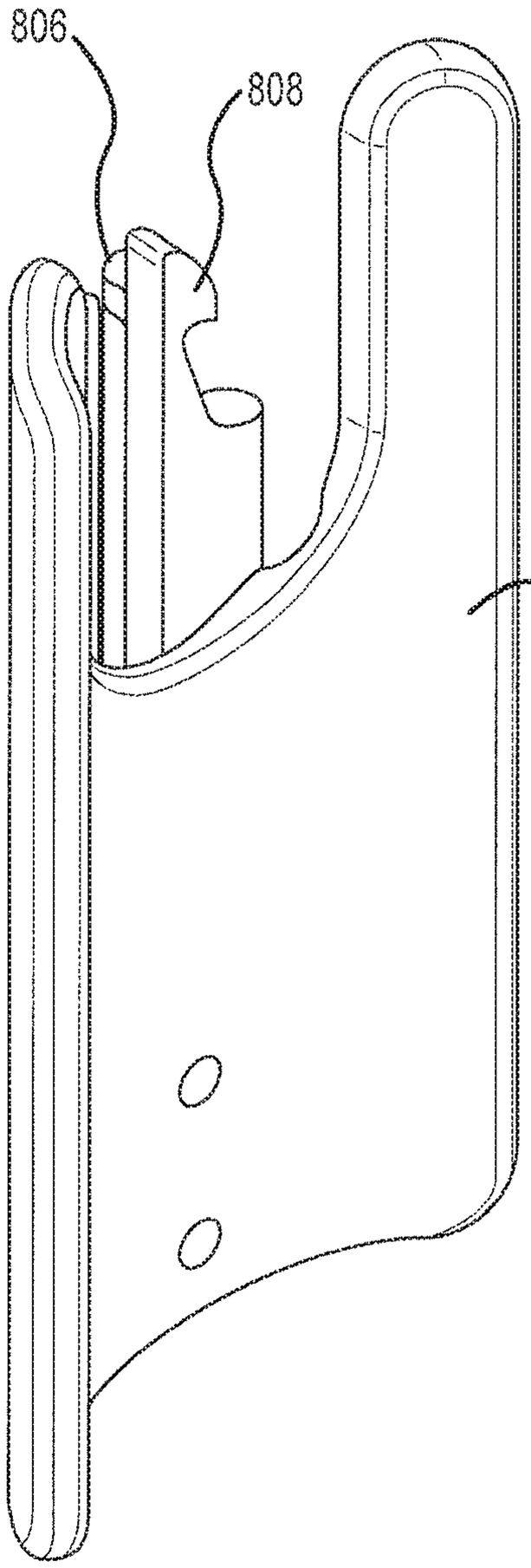


FIG.8C

FIG.8D

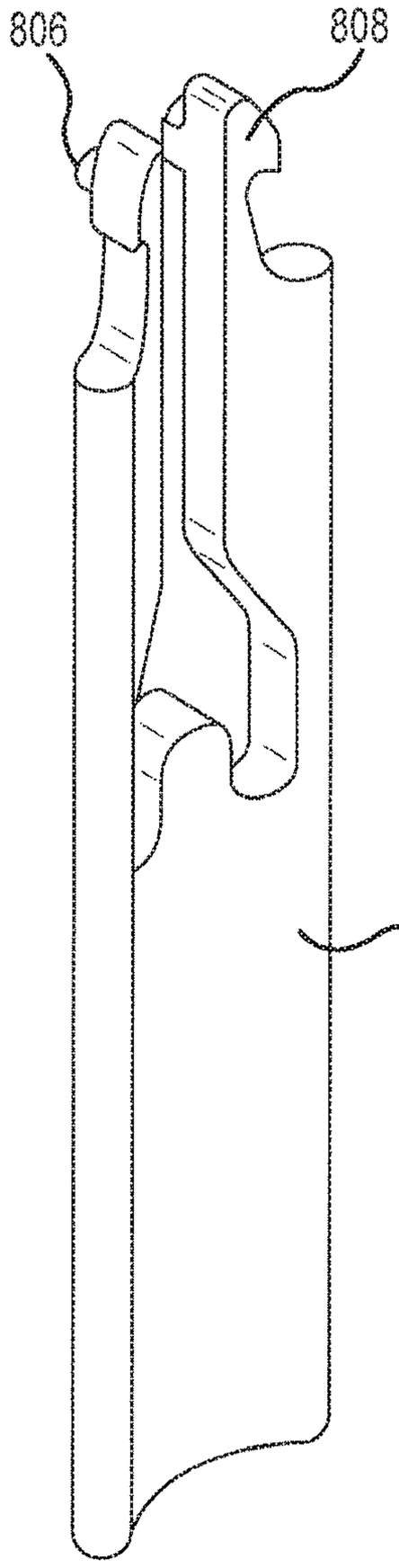
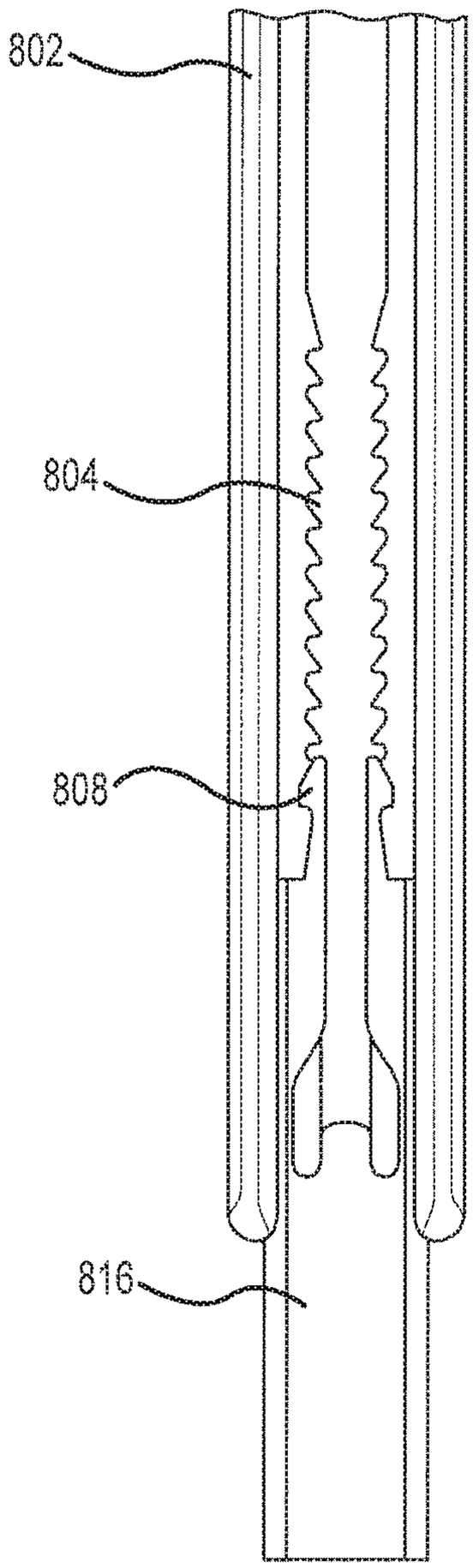


FIG.8E



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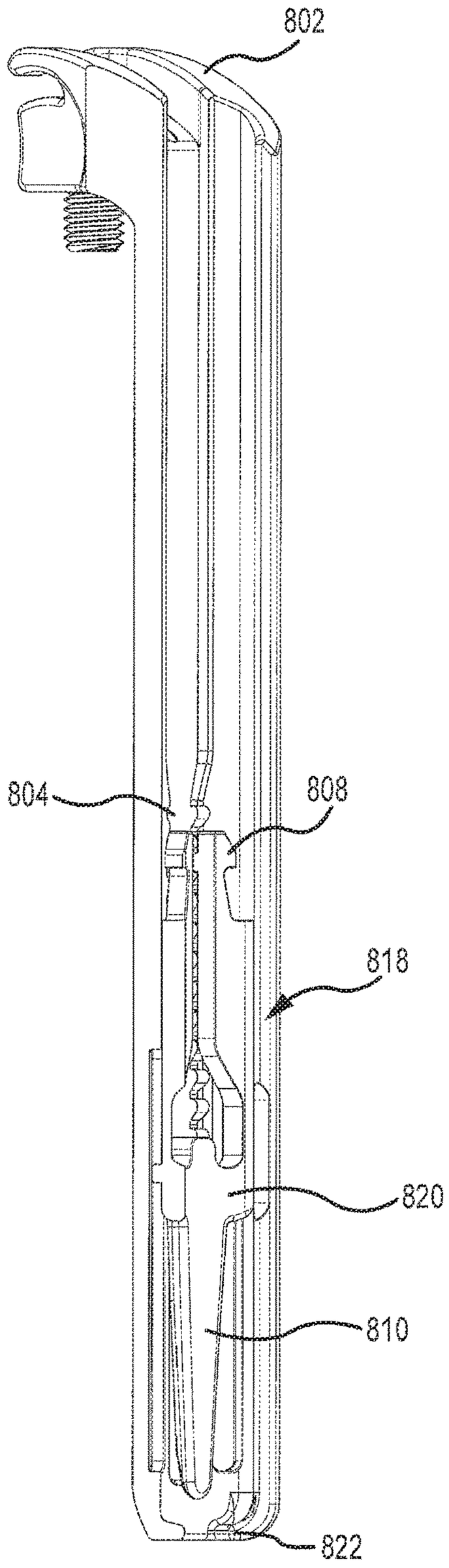

FIG.8G

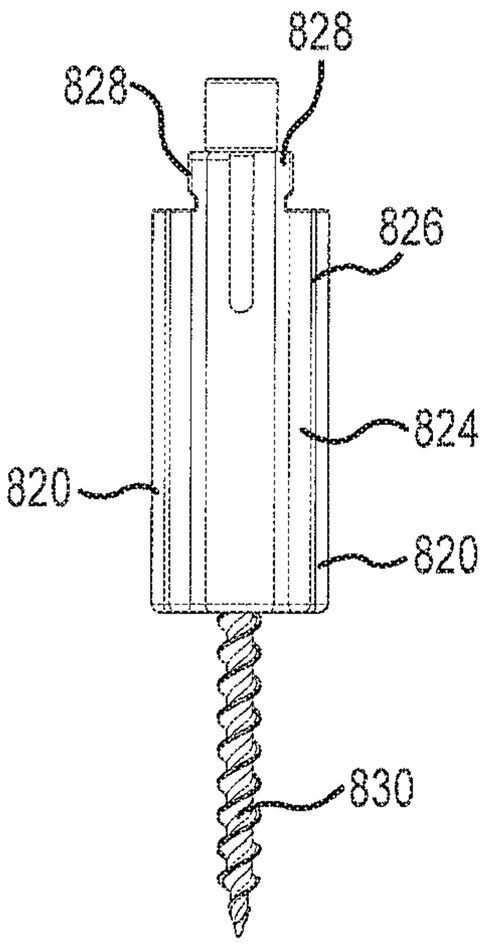

FIG.8H

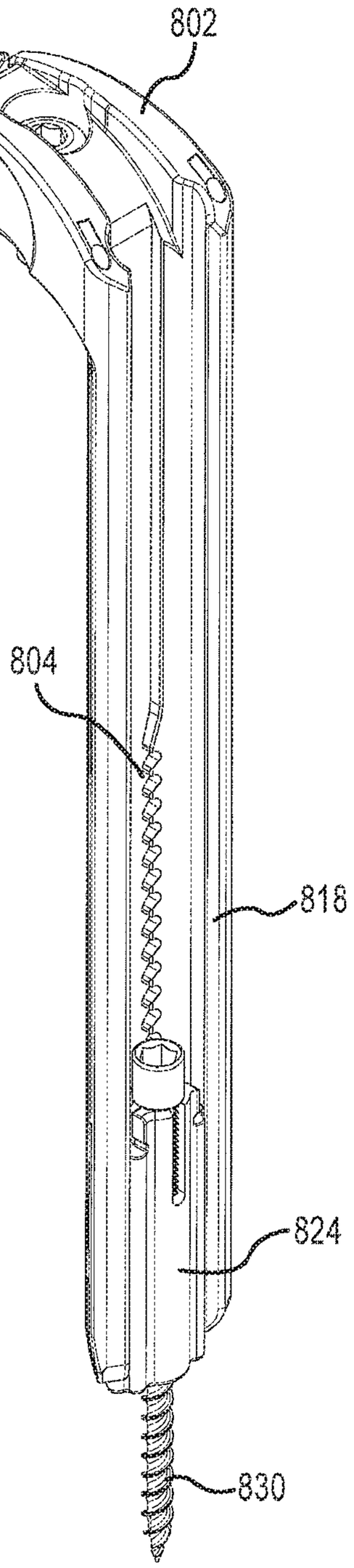

FIG.8I

FIG.8J

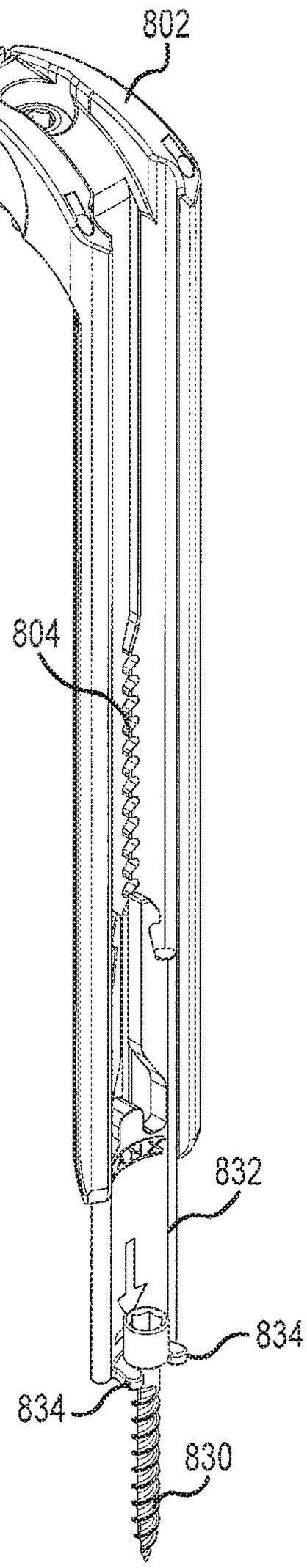

FIG.8K

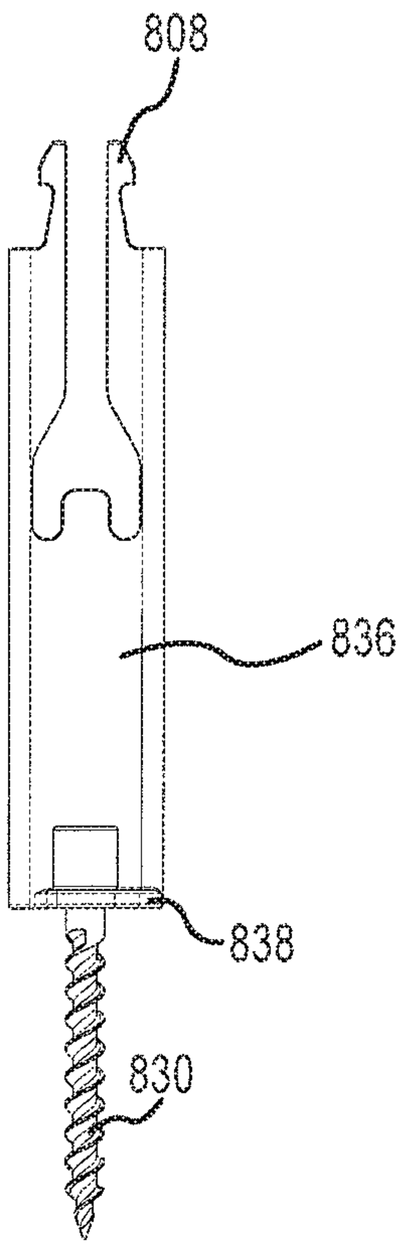

FIG.8L

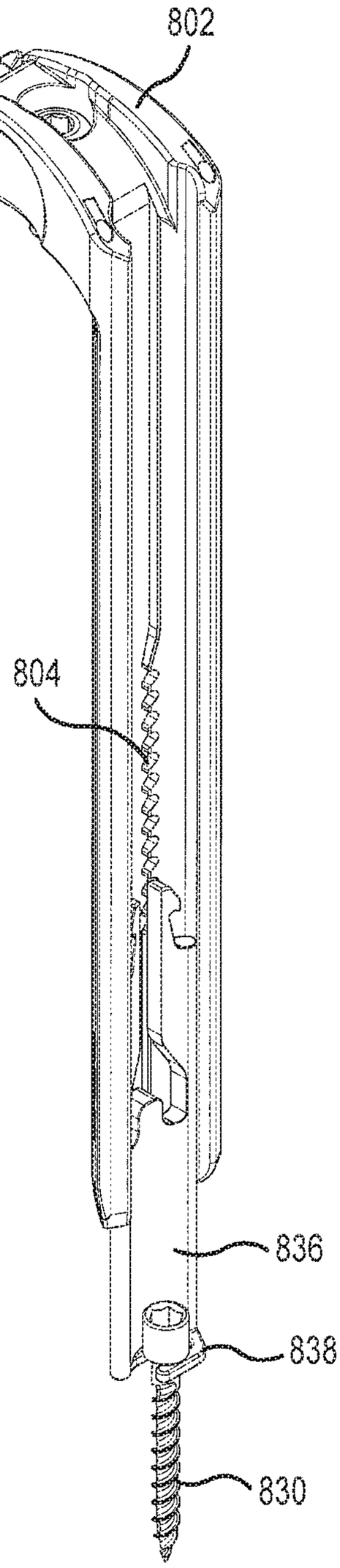

FIG.8M

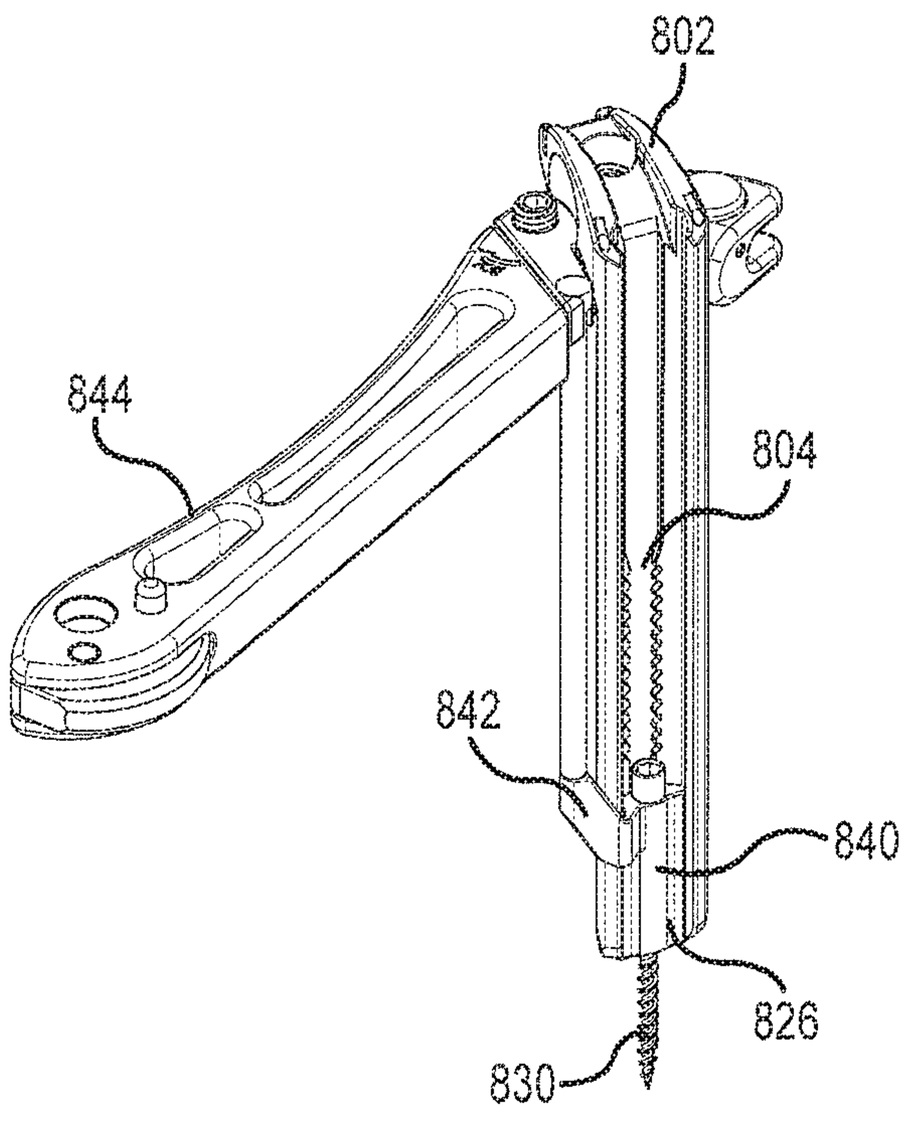

FIG.8N

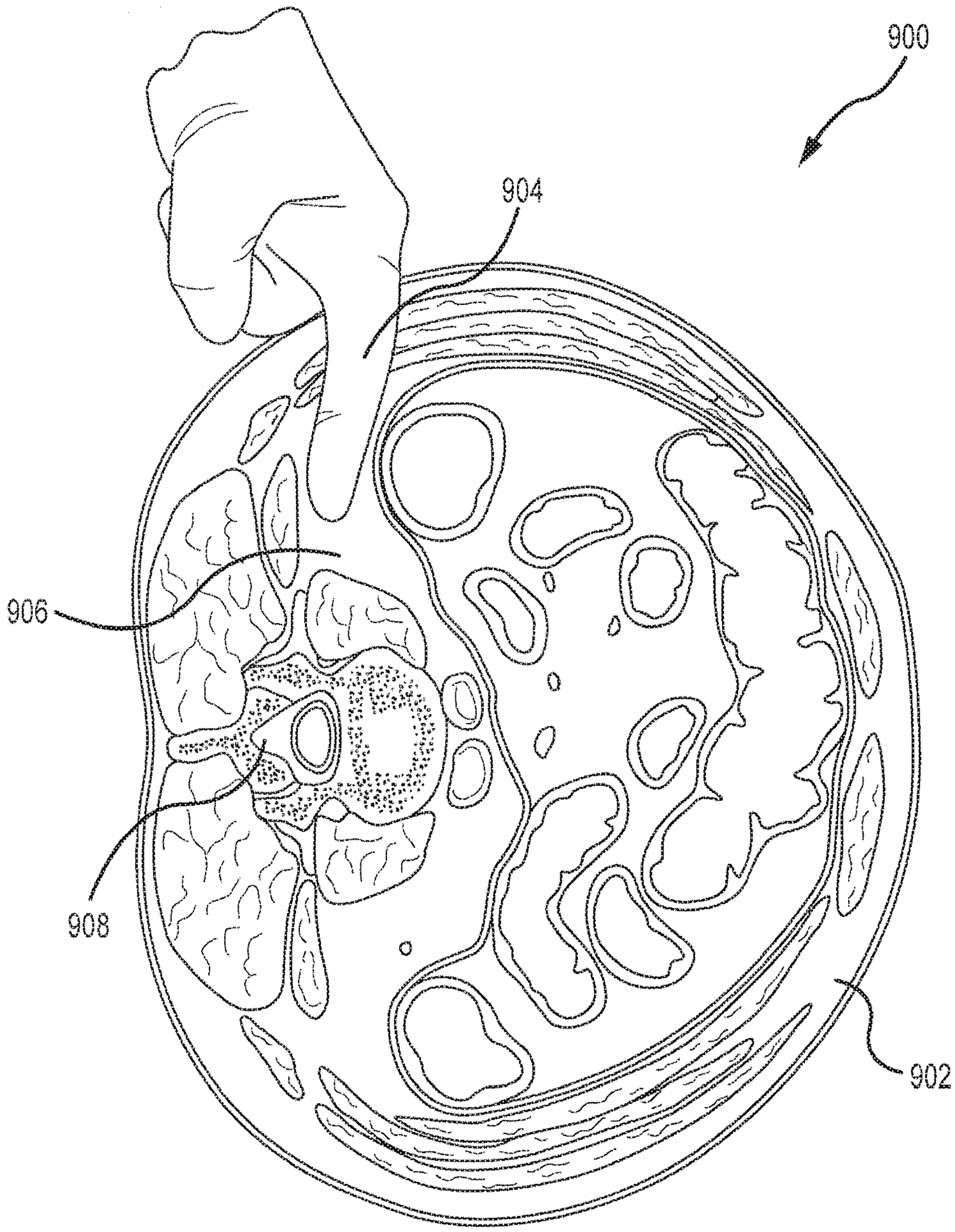

FIG.9A

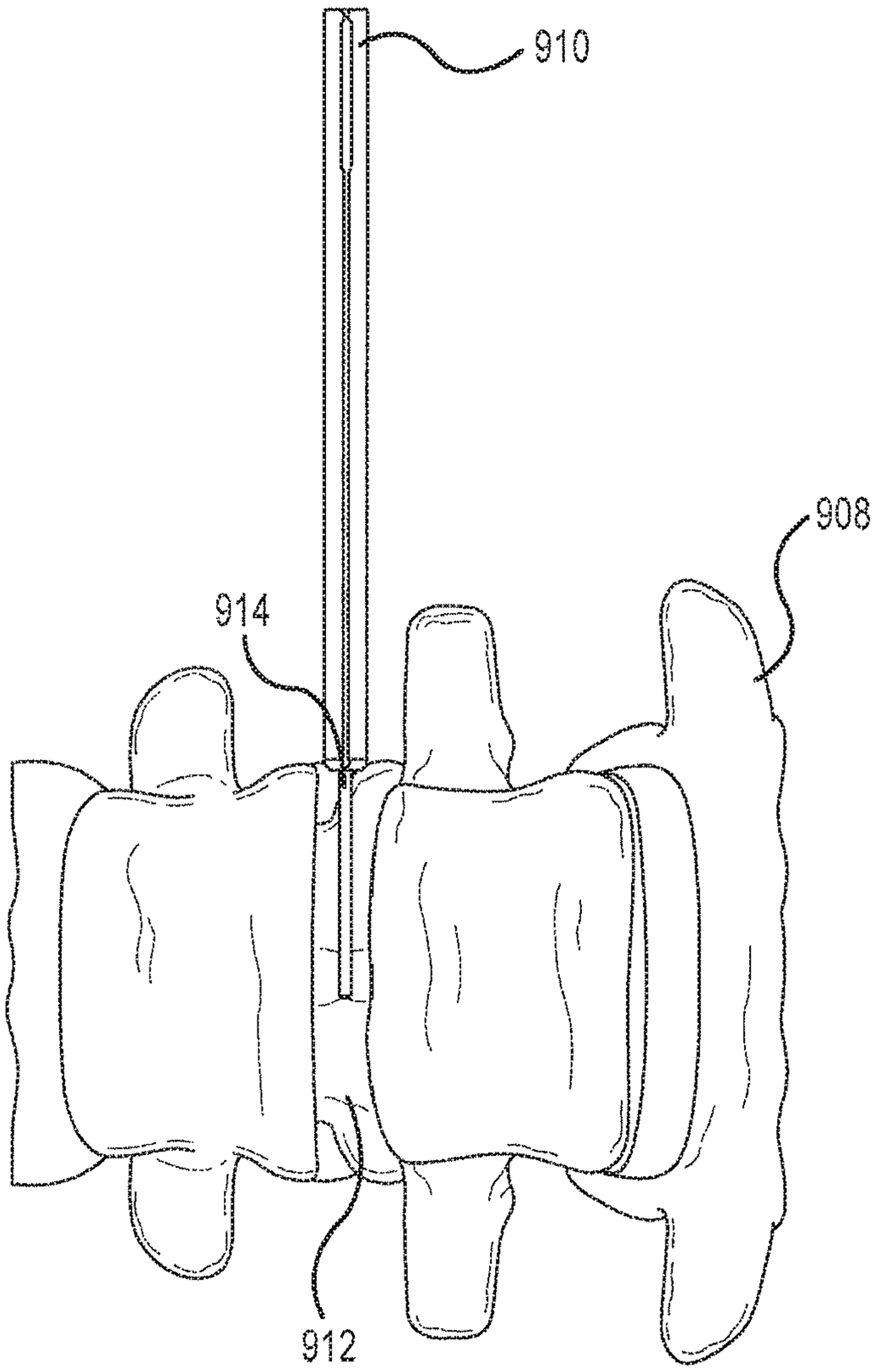

FIG.9B

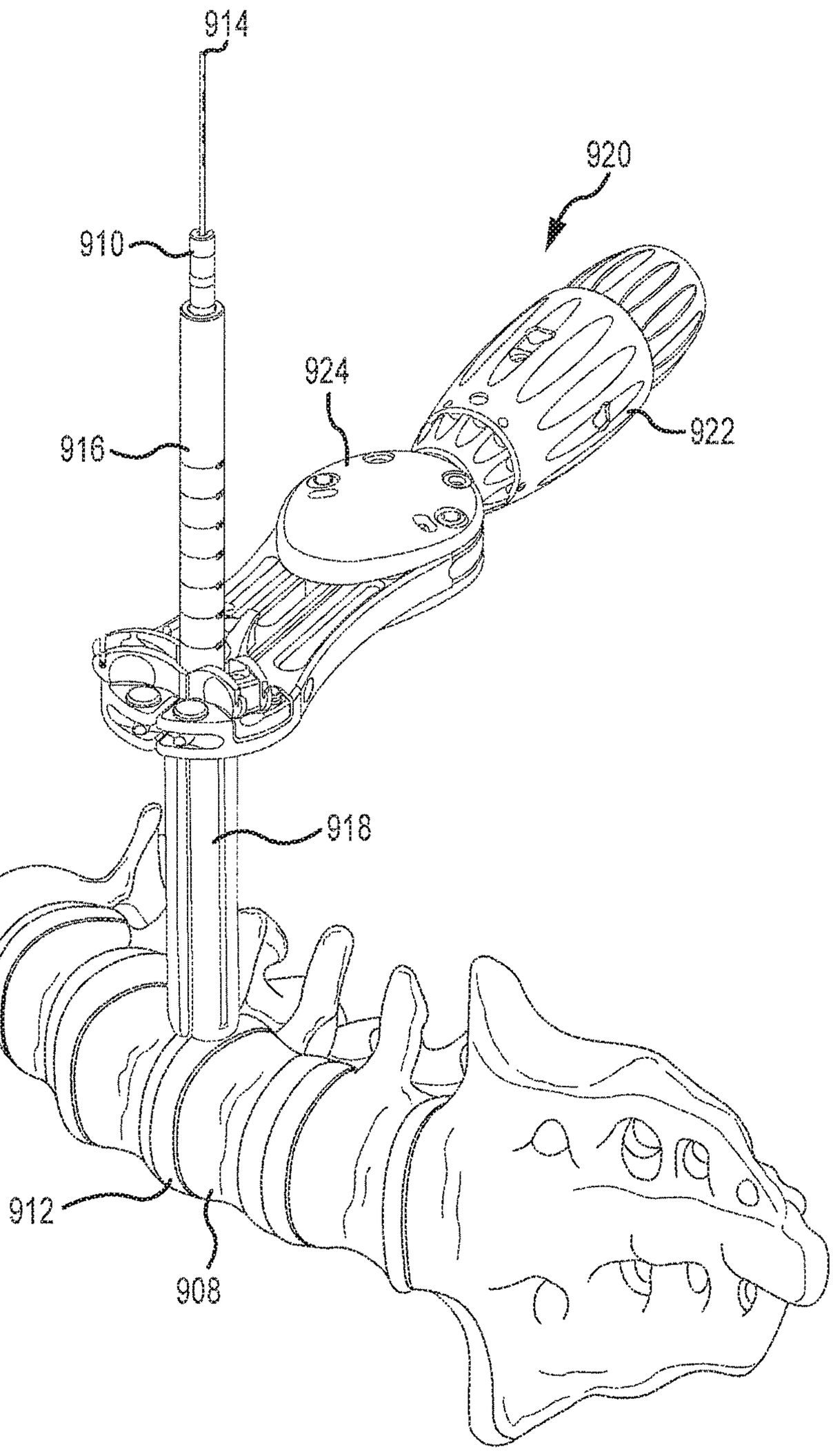

FIG.9C

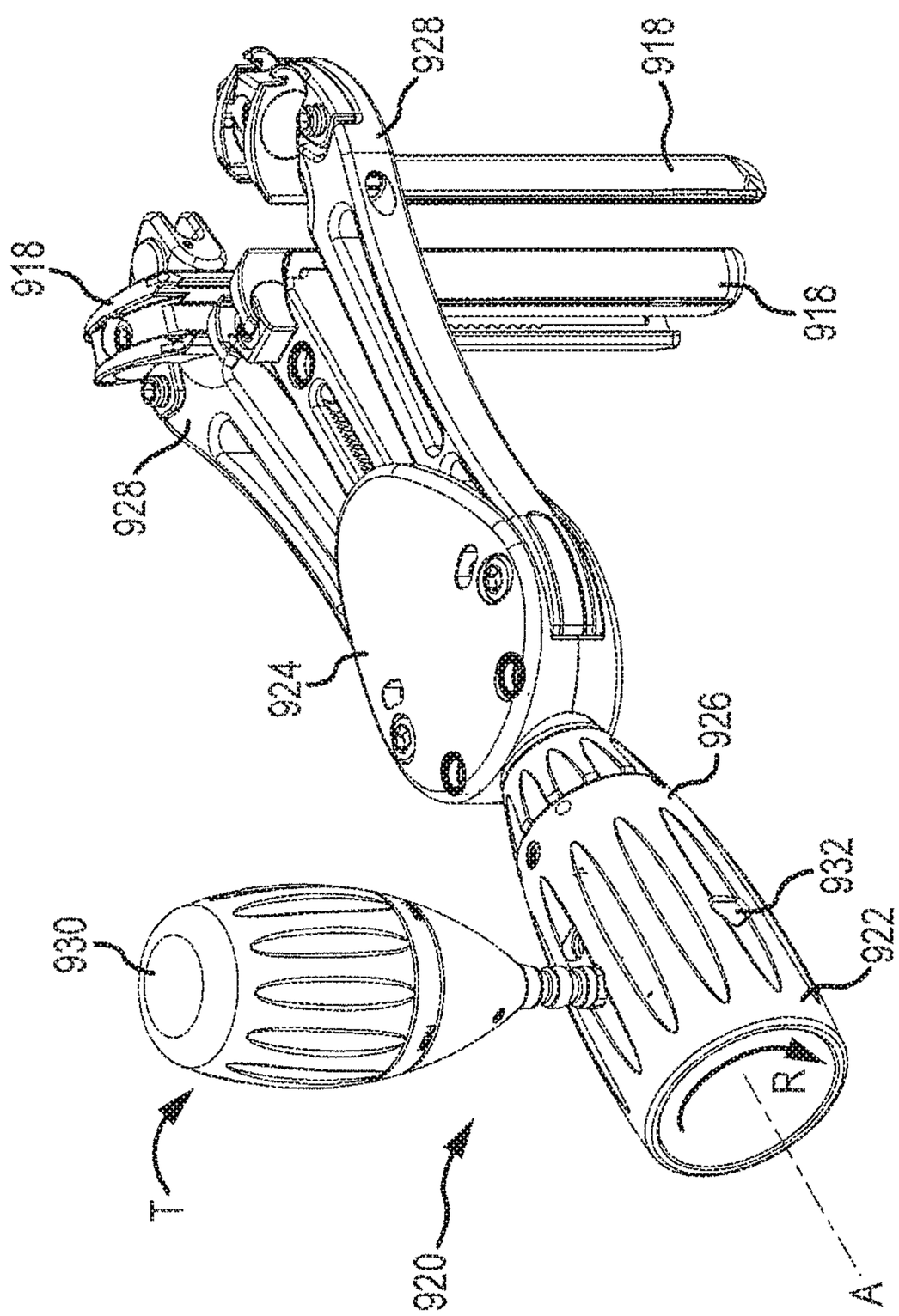

FIG.9D

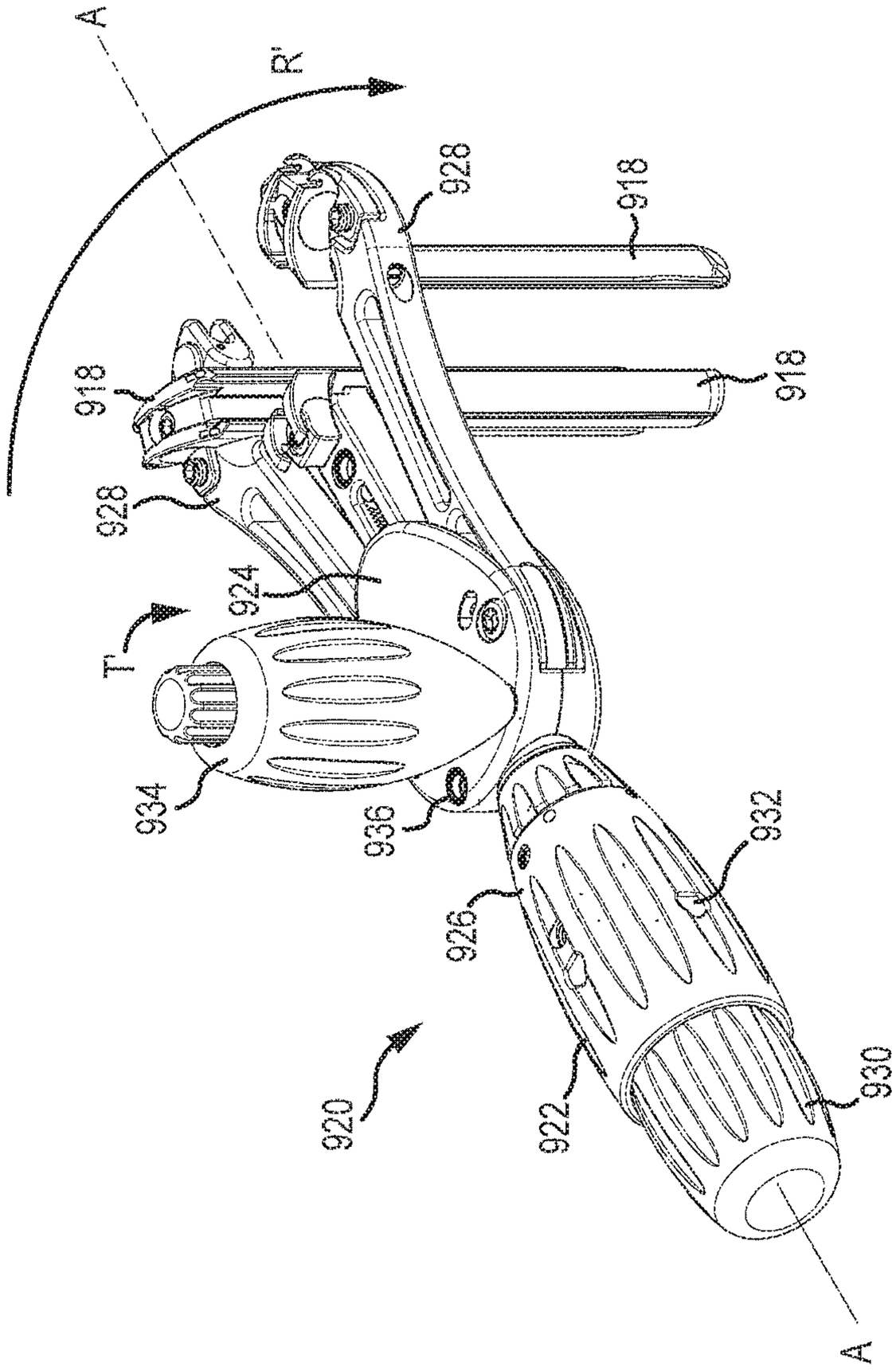

FIG.9E

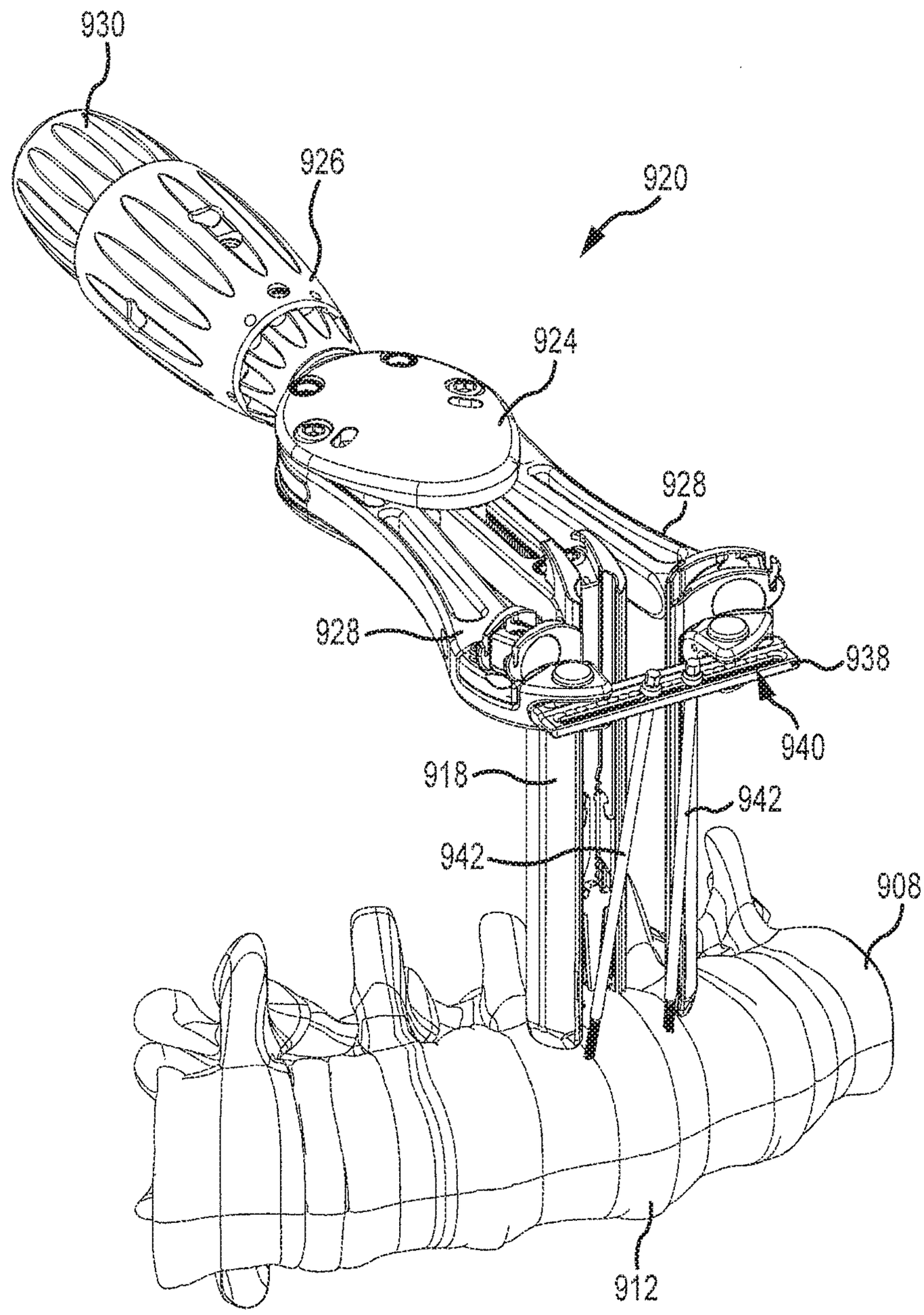

FIG.9F

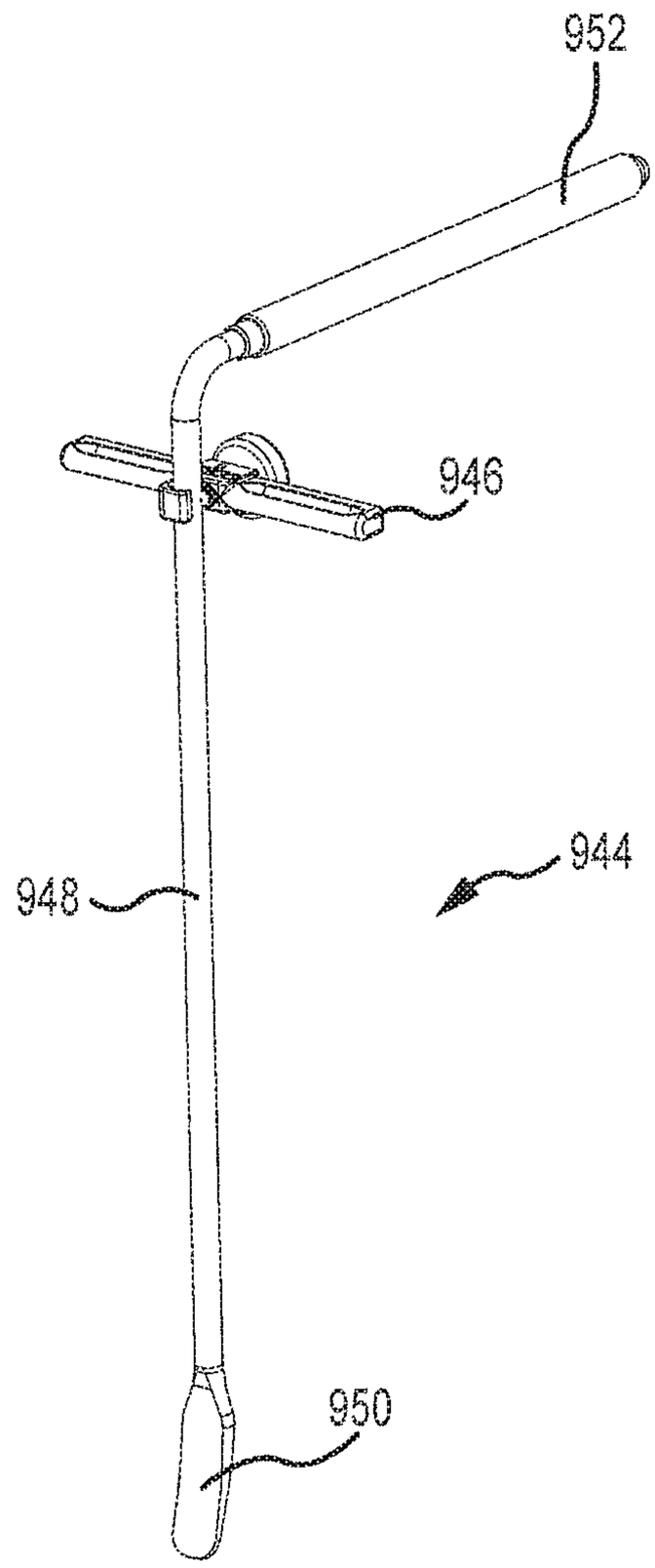

FIG.9G

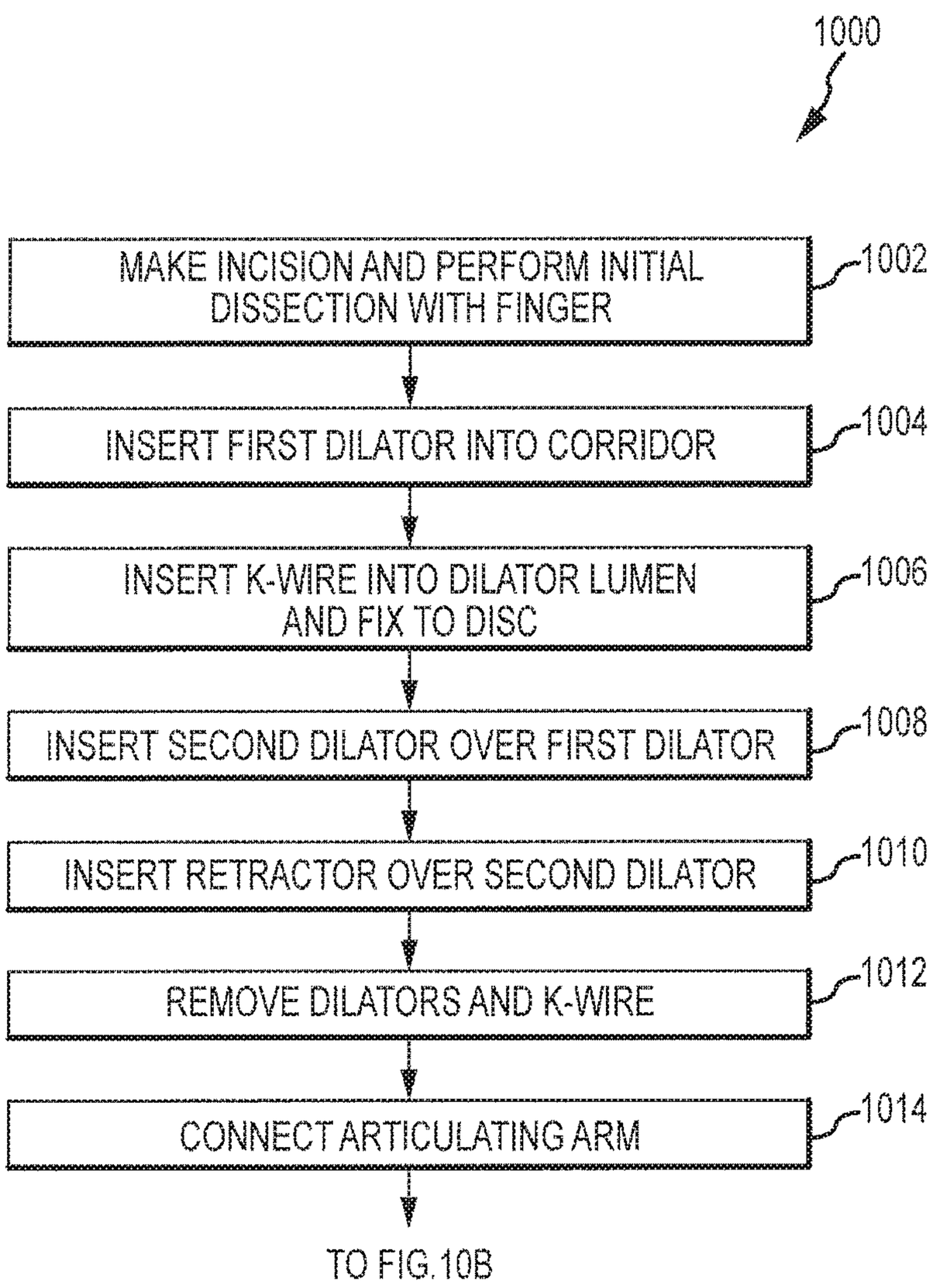
1000
MAKE INCISION AND PERFORM INITIAL DISSECTION WITH FINGER
1002
INSERT FIRST DILATOR INTO CORRIDOR
1004
INSERT K-WIRE INTO DILATOR LUMEN AND FIX TO DISC
1006
INSERT SECOND DILATOR OVER FIRST DILATOR
1008
INSERT RETRACTOR OVER SECOND DILATOR
1010
REMOVE DILATORS AND K-WIRE
1012
CONNECT ARTICULATING ARM
1014
TO FIG.10B

FIG.10A

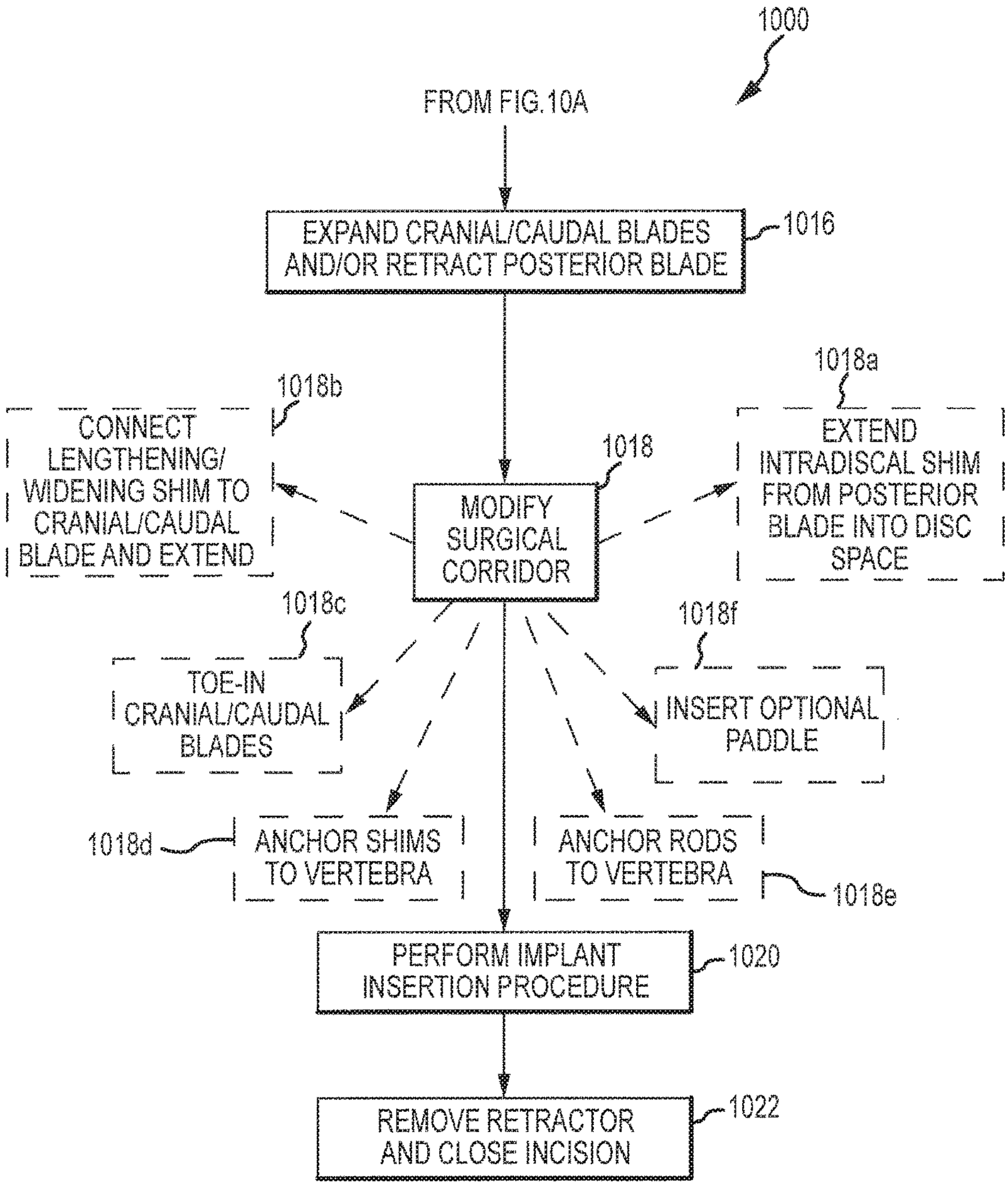
1000
FROM FIG.10A
EXPAND CRANIAL/CAUDAL BLADES AND/OR RETRACT POSTERIOR BLADE
1016
MODIFY SURGICAL CORRIDOR
1018
CONNECT LENGTHENING/ WIDENING SHIM TO CRANIAL/CAUDAL BLADE AND EXTEND
1018b
EXTEND INTRADISCAL SHIM FROM POSTERIOR BLADE INTO DISC SPACE
1018a
TOE-IN CRANIAL/CAUDAL BLADES
1018c
INSERT OPTIONAL PADDLE
1018f
ANCHOR SHIMS TO VERTEBRA
1018d
ANCHOR RODS TO VERTEBRA
1018e
PERFORM IMPLANT INSERTION PROCEDURE
1020
REMOVE RETRACTOR AND CLOSE INCISION
1022

FIG.10B

LATERAL RETRACTOR SYSTEM AND METHODS OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 15/372,426, filed Dec. 8, 2016, which is a continuation of U.S. patent application Ser. No. 15/183,380, filed Jun. 15, 2016, which is a continuation of U.S. patent application Ser. No. 13/601,887, filed Aug. 31, 2012, now issued as U.S. Pat. No. 9,572,560, which claims priority to and the benefit of U.S. Provisional Application Ser. No. 61/529,756, filed Aug. 31, 2011, entitled, "Lateral Retractor System and Methods of Use," the disclosure of which is hereby incorporated by reference herein in its entirety.

INTRODUCTION

Current retractor systems for lateral spine surgical procedures create an opening through the side of a patient, and may pass through the psoas muscle. Improved systems are desirable with respect to at least ease of use, stability, visibility and robustness.

SUMMARY

In one aspect, the technology relates to retractors and methods of use for surgical procedures, and in particular, spinal surgical procedures. In one embodiment, a surgical retractor includes a pair of pivotable armatures and a translatable armature. A body for supporting the armatures is provided, with a handle connected thereto. The handle includes a first rotary actuator, wherein a rotation of the first rotary actuator moves the pair of pivotable armatures in opposite arcuate directions, and a second rotary actuator, wherein a rotation of the second rotary actuator translates the translatable armature in a linear direction.

In one embodiment, a method of creating a distraction corridor to a surgical site is disclosed. The method includes providing a surgical retractor having a handle comprising two rotatable elements, and a plurality of blades moveable relative to the handle. The method includes inserting the plurality of blades simultaneously into a body tissue; actuating a first of the two rotatable elements so as to separate at least two of the plurality of blades; and actuating a second of the two rotatable elements so as to translate at least one of the plurality of blades.

BRIEF DESCRIPTION OF THE DRAWINGS

There are shown in the drawings, embodiments which are presently preferred, it being understood, however, that the technology is not limited to the precise arrangements and instrumentalities shown.

FIG. **1** depicts a perspective view of a retractor device in an open position.

FIG. **2** depicts a partial enlarged top view of a retractor device with a top cover removed

FIG. **3**A depicts a top view of a retractor device in a closed position.

FIG. **3**B depicts a top view of a retractor device in an open position.

FIG. **4** depicts a partial exploded perspective view of a handle of a retractor device.

FIGS. **5**A-**5**C depict enlarged partial perspective views of a locking element in various positions.

FIGS. **6**A-**6**C depict enlarged partial views of a blade/arm interface of a retractor device.

FIG. **7** depicts a side view and enlarged partial side views of a dilator.

FIGS. **8**A and **8**B depict a perspective view of an intradiscal shim, and the intradiscal shim extending from a blade, respectively.

FIGS. **8**C and **8**D depict a perspective view of a widening shim, and the widening shim connected to a blade, respectively.

FIGS. **8**E and **8**F depict a perspective view of a lengthening shim, and the lengthening shim connected to a blade, respectively.

FIG. **8**G depicts a sectional view of the intradiscal shim and blade of FIG. **8**B.

FIGS. **8**H and **8**I depict a perspective view of a first anchoring shim, and the first anchoring shim connected to a blade, respectively.

FIGS. **8**J and **8**K depict a perspective view of a second anchoring shim, and the second anchoring shim connected to a blade, respectively.

FIGS. **8**L and **8**M depict a perspective view of a third anchoring shim, and the third anchoring shim connected to a blade, respectively.

FIG. **8**N depicts a perspective view of a fourth anchoring shim connected to a blade.

FIGS. **9**A-**9**F depict a method of using a retractor system for a lateral spinal surgical procedure.

FIG. **9**G depicts a paddle for use with a retractor system.

FIGS. **10**A and **10**B depict a method of using a retractor system.

DETAILED DESCRIPTION

FIG. **1** depicts a retractor device **100** that includes a main retractor body **126**, a handle **114**, and a plurality of armatures (arms) **102-106** with blades **118-122** attached thereto. The retractor body **126** includes a number of components that drive the operable elements of the retractor device **100**. The arms **102-106** may be opened and closed by rotating actuators **128**, **130** on the handle **114**. The blades **118-122** attached to each arm **102-106** are used to form a surgical distraction corridor in a body tissue. This corridor is enlarged as the arms **102-106** are opened. These and other elements of the retractor device **100** are described in more detail below.

In the depicted embodiment, the retractor body **126** includes a top cover plate **108** and a bottom cover plate (not seen in FIG. **1**) that limit access to the drive elements located therein. The top cover **108** plate includes one or more slots **116**. In some embodiments, each of the two pivoting arms **102**, **106** is connected to a guide pin (not seen in FIG. **1**). The pin is located within the slot **116**, and restricts movement of the arm **102**, **106** to which it is connected as the arm **102**, **106** is opened and closed. In the depicted embodiment, a slot **116** is associated with each of the pivoting arms, with two pins and slots **116** operating together to restrict the movement of arms **102**, **106**. In other embodiments, only a single slot **116** may be used. In certain embodiments, the slot(s) **116** may be entirely eliminated. Inclusion of the slot **116**, however, helps control the connection between the pivoting arm **102**, **106** and the retractor body **126**. One or more articulating arm connection points **110**, **124** may also be located on the top cover **108**. These connection points **110**, **124** may be used to connect the retractor device **100** to a discrete articulating arm that is connected to a surgical table or other substantial element. Rigid connection of the retractor device **100** to the

surgical table or other fixed structure allows the device **100** to be held in place, so the surgeon may be free to perform other aspects of a procedure without having to hold the retractor device **100**.

The retractor body **126** is connected to a handle **114** that may be disengageable, as described below. In the depicted embodiment, the handle **114** includes two rotatable actuators **128**, **130** that are used to actuate the arms of the retractor device **100**. In some embodiments, rotation of the main retractor actuator **128** (centrally located on the handle **114** in the depicted embodiment) actuates the two pivoting arms (i.e., the cranial and caudal arms **102**, **106**). In some embodiments, rotation of the posterior actuator **130** (located at the end of the handle **114** in the depicted embodiment) actuates the posterior arm **104**. In alternative embodiments, the position of the actuators **128**, **130** may be switched or otherwise vary. In other embodiments, each armature has a separate handle rotatable actuator to allow the armatures to be opened individually. In still other embodiments, the handle contains a single rotatable actuator that actuates all of the armatures simultaneously. The rotational axis A is shared by both the main retractor actuator **128** and the posterior actuator **130**. In alternative embodiments, other actuator elements may be used. In one example, the actuator element for the pivoting arms may be a circular disc having an axis of rotation substantially orthogonal to the axis A of the handle **114**. The disc may be connected to a worm gear, lead screw (FIG. **2**), or other element within the handle **114** that operates the pivoting arms **102**, **106**. A similar disc may be used for the posterior arm **104**. Alternatively, a translating element, for example a slide movable parallel to the axis of the handle **114**, may be used to actuate the posterior arm **104**. As described in more detail below, some or all of the handle **114** may be removably connected to the retractor body **126**. A connection element **112** may connect the handle **114** to the retractor body **126**. In certain embodiments, the connection element **112** incorporates a lock having multiple positions and functions as described below with regard to FIGS. **5**A-**5**C.

In some embodiments, retractor **100** includes three arms **102-106** used to help form a surgical distraction corridor in a body tissue. In some cases, arms **102-106** include two pivoting arms **102**, **106** and one translating arm **104**, with each or some having a blade **118-122** extending therefrom. A first end of each of the pivoting arms **102**, **106** is attached to the retractor body **126**. The opposite end of each arm **102**, **106** is secured to a blade **118**, **120** that is inserted into the body tissue. For certain embodiments, such as when retractor **100** is used in a lateral spinal surgical procedure, the terms "cranial" and "caudal" may be associated with certain arms **102**, **106** and blades **118**, **120** to help identify their position relative to the patient. For example, arm **102** and blade **120** may be referred to as caudal arm **102** and caudal blade **120**. Similarly, arm **106** and blade **118** may be referred to as a cranial arm **106** and cranial blade **118**. In that regard, the cranial blade **118** is located on the side of the retractor **100** closest to the head of the patient, while the caudal blade **120** is located on the side of the retractor **100** closest to the legs. The cranial and caudal blades **118**, **120** are similarly configured, such that either blade **118**, **120** may be considered either the cranial or caudal blade, depending on which side the patient is laying during a surgical procedure. In one embodiment, both pivoting arms **102**, **106** (and therefore both blades **118**, **120**), pivot in an arcuate direction away from a centerline of the retractor device **100**, defined by the axis A of the handle **114**, as the main actuator **128** is rotated. Of course, other embodiments of the retractor device may be configured such that separate actuators are used for each of the two pivoting arms **102**, **106**. Using a single actuator for both pivoting blades **118**, **120**, however, helps ensure even opening of the surgical corridor during use and a balancing of forces against the blades **118**, **120**.

The translating arm **104** has first and second ends, with the first end connected to the main retractor body **126** and the second end connected to a blade **122**. The translating arm **104** may be referred to as the posterior arm **104** and is configured to move axially along the axis A. That is, the arm **104** may be drawn into and extended out of the retractor body **126**, as the posterior actuator **130** is actuated. The posterior arm **104** may also include an articulating arm connection element **132**, thereby providing an additional point of connection of the retractor device **100** to the surgical table or other secure structure. The posterior blade **122** is secured to the translating arm **104**, either directly or with a pivotable connection as described above with regard to the blades **118**, **120**. Additionally, although the device **100** is typically utilized such that the handle **114** is pointed toward the surgeon, the device **100** may also be oriented so that the handle **114** is pointed away from the surgeon during use. In that case, the translating arm **104** may be referred to as an anterior arm **104**.

FIG. **2** depicts an embodiment of the drive mechanisms for opening and closing the arms **102-106** of the retractor device **100**. As shown, a main worm drive mechanism **214** or lead screw is used to actuate the cranial and caudal arms **102**, **106**. Rotation of the main worm drive **214** by the main actuator **128** (not shown) rotates the main worm gears **210**, **212**, thereby separating or pivoting the cranial and caudal arms **102**, **106**. In some embodiments, worm drive **214** engages teeth on worm gears **210**, **212**. In one embodiment, the use of a worm drive mechanism **214** to separate the cranial **118** and caudal blades **120** allows for a large number of open positions between the blades **118**, **120**. In some cases, the worm drive mechanism **214** provides an unlimited number of open positions depending on the amount of rotation of main worm drive **214**. Additionally, the blades **118**, **120** are brought together using the worm drive mechanism **214**. In other words, the worm driver **214** and worm gear mechanisms **210**, **212** prevent the cranial arm **102** and caudal arm **106** from moving unless specifically actuated. In this manner, the blades **118**, **120** are maintained in a desired position until the worm drive mechanism **214** is actuated to further open or close the blades **118**, **120**. A posterior drive element may be a lead screw **204** mechanism that is engaged with a lead nut **202** to the translating arm **104**, allowing for movement of the translating arm **104**. In the depicted retractor device **100**, the shaft that connects the lead screw **204** to the posterior actuator **130** passes through the main worm drive **214** that activates the cranial and caudal arms **102**, **106**. As with the worm drive **214**, forces applied directly to the posterior blade **122** or arm **104** will not move those elements, compared to a ratchet-type or other system.

FIGS. **3**A and **3**B depict the retractor device **100** in closed and open positions, respectively. When in the closed position, in one embodiment, the blades **118-122** form a perimeter that is configured to surround one or more generally round dilators (FIG. **7**) that are first introduced into a body tissue. These dilators and the use thereof, are further described below. The blades **118-122** need not abut one another but may be so configured if desired. Gaps or spaces between the blades **118-122** when in the closed position are generally not a concern unless these gaps are large enough to allow creep of tissue between the blades **118-122**. In a particular embodiment, a gap exists between the cranial

blade **118** and the caudal blade **120**, even when the cranial arm **106** and caudal arm **102** are in a closed and abutting position. In some embodiments the gap extends the entire length of blades **118** and **120**. Rotating the main actuator **128** located on the handle **114** moves the arms and the blades **118**, **120** away from each other, in arcuate directions. Rotation of the posterior actuator **130** moves the posterior arm **104** and blade **122**. When the blades **118-122** are inserted into a body tissue, this movement forces the tissue apart, creating a surgical corridor, the interior of which may be accessed by a surgeon.

FIG. **4** depicts a partial exploded view of an embodiment of the handle **114**, specifically, the portion of the handle **114** that actuates the cranial and caudal arms **102**, **106**. The main actuator **128** portion of the handle **114** is connected to an elongate shaft **408**. The connection element/lock **112** includes an internal thread connection **404** that mates with a corresponding thread connection **404'** on a friction sleeve **402**. Rotation of the connection element/lock **112** rotates the friction sleeve **402**. A number of locking elements **406** project from the friction sleeve **402** and engage with a collar **416**. As the locking elements **406** engage with the collar **416**, functionality of the retractor device **100** changes, as described with regard to FIGS. **5**A-**5**C. Collar **416** is coupled to core **410**. In one embodiment, pins **412** couple collar **416** to core **410** and are welded or otherwise affixed in place.

FIG. **5**A depicts a first position of the connection element **112**, as that element engages with the collar **412**. In this position, referred to as a "soft engagement" position, ball bearings **414** are free to move within the constraints of a C-spring **502**, because of openings **418** present between the locking elements **406** of the friction sleeve **402**. FIG. **5**B depicts a second position, wherein the connection element **112** is rotated a desired or set amount, such as about thirty (30) degrees, about forty-five (4S) degrees, about sixty (60) degrees, or the like. In this position, the locking elements **406** are moved forward, such that the C-spring **502** is locked out, thereby restricting movement of the ball bearing **414**. This position captures the shaft **406** and allows the retractor arms to be opened and closed. FIG. **5**C depicts a third position, wherein the connection element **112** is rotated an additional desired or set amount, such as about another thirty (30) degrees, about another forty-five (4S) degrees, about another sixty (60) degrees, or the like. This moves the friction sleeve **402**, and therefore the locking elements **406**, further forward so as to engage a corresponding toothed plate in the retractor body **126**. In this position, the friction sleeve **402** is in the fully locked position, such that the gaps **418** are restricting the C-spring **502** from expanding. This locks the ball bearings **414** in place, and the locking elements **406** are in a position where they will interface with the corresponding teeth in the retractor body **126** (not shown). The center core **410**, the handle body, and the collar **416** are fixed relative to each other, using a variety of techniques. For example, in one embodiment pins **412** couple collar **416** to core **410**.

FIGS. **6**A-**6**C depict enlarged partial views of a blade/arm interface **600**, and show various technologies incorporated therein. FIG. **6**A depicts an end of the cranial arm **106**, and blade **118**. The blade **118** is pivotably connected to the arm **106**, specifically with a blade base **604** that is positionable within a toeing cut-out **606** in the arm **106**. In one embodiment, blade **118** has a curved proximal end which engages the blade base portion of arm **106**. The blade base **604**, in one embodiment, is rotatably coupled to arm **106**. In this embodiment, a blade attachment mechanism, depicted in FIG. **6**B as a screw **612**, threads through a hole in blade **118** proximal end and into a threaded opening in the top of blade base **604**. Once blade **118** is coupled to the blade base **604** of arm **106**, rotation of the blade base **604** allows the distal end of blade **118** to be toed in a desired direction as described below. In a particular embodiment, a toeing screw **608** is coupled to the blade base **604**. Rotation of toeing screw **608** causes movement of the blade base **604** relative to arm **106**. In a particular embodiment, toeing screw **608** extends through a threaded hole in blade base **604**. Further rotation of toeing screw **608** causes the tip portion of screw **608** to engage toeing cut-out **606** and thereafter provide for rotation of the blade base **604** relative to cut-out **606**. In this manner, blade **118** also rotates, which allows the distal end of the blade **118** to move past its initial orientation that is generally orthogonal to the arm **106**. In certain embodiments, each of the cranial and caudal blades may be toed up to about ten (10) degrees, up to about twenty (20) degrees, or up to about thirty (30) degrees from orthogonal. In a preferred embodiment, the toeing of blades **118**, **120** allows the distal ends of blades **118**, **120** to be toed outwards, providing a larger opening near the operative site. Regardless of the maximum toeing angle, the toeing screw **608** allows for infinite degrees of variability across the entire range of motion. In certain embodiments, the posterior blade (not shown) may be toed as well, although the posterior blade **122** typically does not have toeing ability. This toeing functionality may also be incorporated into the caudal arm **102**, as depicted in FIG. **6**B. While the depicted embodiment shows blade **118** proximal end coupled to a rotatable blade base **604**, in another embodiment the proximal end of blade **118** includes structure for providing the rotation function. In this manner, the blade **118** is firmly coupled to the arm **106**, but provides the rotation for a controlled toeing function.

FIG. **6**B also depicts one or more channels **602** on the blade **120** that each may receive a probe, a K-wire, a stimulation electrode, or the like. In some embodiments, the stimulation electrode may be used to detect the location, and/or proximity of nerves in the target area, which may help avoid damage to the nerves. FIG. **6**C depicts a rear perspective view of the caudal blade **120** of FIG. **6**B. The channel **602** for receiving the probe may be a substantially open slot along a rear face of the blade **118**, as depicted in FIG. **6**C. In general, the channel **602** may extend to a distal end of the blade **118**, such that the electrode may detect the location and/or proximity of any nerves once it is advanced into the tissue. Of course, channels **602** may be located elsewhere on the blade **118** as well. In certain embodiments, the channel **602** extends along only a portion of the length of the blade **118**, or is not present at all. In some embodiments, the channel **602** has a jog, a bend, or a narrowed region along at least a portion of the length of channel **602**. In some embodiments, the jog or bend is near the distal end of blade **118**. In this manner, the elongated flexible element, such as a K-wire or probe, inserted into the channel **602** is at least partly held in place within channel **602** due to the increased friction needed to move the flexible element relative to the jog, bend or narrowed portion. This feature may be useful, for example, to help maintain the flexible element within channel **602** while blade **118** is being inserted or removed from the patient tissue.

FIG. **7** depicts side and enlarged partial side views of a dilator **700** that may be used in conjunction with the retractor depicted herein. One or more dilators **700** may be used to further increase a diameter of an initial distraction corridor as described in more detail below. Similar to the channel located on the retractor blade(s), a channel **702** may also be located on the dilator(s) **700**, and may be sized to accom-

modate a stimulation electrode, a probe, or other elongate element. In certain embodiments, a single stimulating electrode may be used with each component (e.g., a first dilator, a second dilator, retractor blade) introduced into the body tissue. After insertion of the first dilator, the electrode may be withdrawn and inserted into a channel of a next dilator, then into a channel in a retractor blade, until the blades are opened, thereby creating the desired surgical corridor. In some embodiments, a top surface **708** of the proximal end **704** may be constructed of hardened material to allow the dilator **700** to be impacted with an object such as a hammer during insertion. In a particular embodiment, dilator **700** comprises anodized aluminum, with the proximal end **704** comprising a steel impaction cap. In this manner, the proximal end may be struck with a hammer or other impaction tool with little to no deformation of proximal end **704**. In some embodiments, proximal end **704** may be flared (much like the head of a nail). At least a portion of the distal end **706** may be tapered to ease insertion into the initial distraction corridor.

FIGS. **8**A-**8**F depict various embodiments of shims that may be used in conjunction with a retractor device such as described herein. In the depicted embodiments, some of the shims include one or more tabs **806** or other mechanisms to engage a ratcheted groove **804** located on the interior face of the blades **802**. The tab/ratchet interface allows the depth of insertion of the shim to be adjusted based on the needs of the surgeon performing the particular procedure, and the groove **804** is configured such that multiple depths may be achieved. In the depicted embodiment, the groove **804** comprises two opposing ratcheted surfaces that are engaged by opposing tabs **806** on the shim which is, in this case, an intradiscal shim **810**. In some embodiments, tabs **806** extend from flexible arms **808** that may be deflected inward, such as by an elongate instrument used for shim insertion or retraction. Tab **806** is disengaged from the groove **804**, allowing the shim **810** to be moved upward or downward along the blade **802**. In some embodiments, arms **808** are compressed towards each other to allow shim **810** to slidingly engage the blade **802** without a ratcheting of tabs **806** and groove **804**. The outer edges of shim **810** may engage a corresponding feature in blade **802** to allow a sliding or telescoping movement between shim **810** and blade **802**. In some embodiments, one or more outer edges of shim **810** engage a slot, a groove, a lip, an overhang, or the like in blade **802** to provide for a controlled sliding movement of shim **810** relative to blade **802**. In this manner, the shim **810** may be adjusted to a desired position relative to blade **802**, and then released to securely lock in place using tabs **806** and groove **804**. This arrangement also helps prevent the shim **810** from disengaging from blade **802**. The depicted intradiscal shim **810** may be used to fix a position of one of the blades **802** (typically, the posterior blade) relative to a spine. The distal tip **812** of the intradiscal shim **810** is sized and configured so as to be temporarily lodged between two vertebrae during a spinal procedure. The intradiscal shim **810** may, for example, restrict lateral movement of the blade **802** to which the shim **810** is attached. Intradiscal shim **810** also helps restrict blade **802** movement in the cranial-caudal directions, and the anterior-posterior directions as well. A widening shim **814** is depicted in FIGS. **8**C and **8**D and is used, inter alia, to prevent tissue creep into the spaces between the blades **802** when they are opened. A lengthening shim **816** is depicted in FIGS. **8**E and **8**F and is used to lengthen the effective depth of penetration of the blades **802**, allowing a deeper surgical corridor to be opened in a body tissue. In general, the widening and lengthening shim **814**, **816** are utilized on the cranial and caudal blades. In some embodiments, the shims **810**, **814**, **816** are interchangeable, with each available for use with any of the retractor blades **802**.

While the widening shim **814** and lengthening shim **816** are each depicted as discrete from the blades **802**, in alternative embodiments they may be non-removably coupled to the blades **802** prior to insertion into the body tissue. In a particular embodiment, intradiscal shim **810** is slidably and non-removably coupled to the posterior blade. This helps prevent the shim **810** from inadvertently disconnecting from the blade **802**, which would defeat the purpose of using an intradiscal shim **810** to fix the position of the blade **802** in the body. In this manner, the intradiscal shim **810** operates as an extension of the retractor blade **802** when a distal tip **812** of the shim **810** is positioned to extend beyond the distal tip of the retractor blade **802**. When not in use, the shim **810** is withdrawn into the retractor blade **802** such that the distal tip **812** of the shim **810** does not extend beyond the distal tip of the retractor blade **802**.

A configuration of such a blade/shim interface where the shim is not removable from the blade **802** is depicted in FIG. **8**G. The shim **810** and blade **802** are coupled together in a manner to allow a slidable relationship between the shim **810** and the blade **802**. In the depicted embodiment, inner edges **818** of the blade **802** substantially surround wings **820** of the shim **810**, which prevents the shim **810** from being pulled away from the blade **802**. A travel stop **822** is located at a bottom of the blade groove **804** or adjacent the blade groove **804**. The travel stop **822** prevents the shim **810** from being removed from the bottom of blade **802**. In addition, pins or other structure (not seen in FIG. **8**G) operate to restrict movement of shim **810** towards the top of blade **802**. In this manner, intradiscal shim **810** has a limited range of sliding motion relative to blade **802**, but is not removable from blade **802** through either the top (proximal) or bottom (distal) ends of blade **802**.

FIGS. **8**H and **8**I depict an anchoring shim **824** that may be used with the retractor devices described herein. The anchoring shim **824** includes a body **826** that is configured to slide within the groove **804** of the blade **802**. The blade **802** includes inner edges **818** that substantially surround or engage wings **820** of the anchoring shim **824**, similar to the blades and wings depicted in FIG. **8**G, above. Unlike the shims of FIGS. **8**A-**8**G, however, the anchoring shim **824** lacks any rear projections to engage with the ratcheted groove **804**. Instead, the anchoring shim **824** is configured to slide unimpeded along the blade **802**. Tabs **828** may engage with an elongate tool to move the anchoring shim **824** within the groove **804** or to hold the shim **824** steady. Unlike the tabs **806** depicted above, however, these tabs **828** need not be deflected inward to move the shim **824**. Instead, the tabs **828** serve as a point of connection with the elongate tool. In some embodiments, the elongate tool also engages the blade inner edges, wings, grooves, or similar structure of the blade for additional control of shim movements when using the elongate tool. Extending from and through the body **826** is a fastener **830** that may be used to anchor the blade **802** to a vertebral body. In the depicted embodiment, fastener **830** is a threaded screw with a tool engaging proximal portion. Other fasteners also may be used, including pins, elongate wires, or the like. In some embodiments, the anchoring shim **824** is utilized on the cranial or caudal blades, for coupling of the fastener **830** to a vertebral body. A head of the fastener **830** may be actuated by a tool, such as a hex driver or other device for securing the fastener **830** to bone. Once one of either the cranial or caudal blades are anchored via the shim **824**, opening of the retractor device arms will result in the

unanchored blade moving away from the anchored blade, thus moving a central axis of the surgical corridor away from the anchored blade.

FIGS. **8**J and **8**K depict another embodiment of an anchoring shim **832**. This anchoring shim **832** utilizes deflectable tabs **808** to selectively locate associated projections (not shown) within the ratcheted groove **804** (similar to the shims of FIGS. **8**A-**8**G). Two fastener retention ears **834** are located on either side of the vertebral screw **830**. This anchoring shim **832** differs additionally from the anchoring shim **824** of FIGS. **8**H and **8**I in that the fastener holding force provided by the retention ears **834** is less than that provided by the enclosed body **824** of the first anchoring shim **824** of FIGS. **8**H and **8**I. For example, the shim **832** main body and ears **834** generally surround fastener **830** on three sides, leaving a gap on one side. As a result, a force applied to blade **802** in a direction generally opposite this gap may allow shim **832** to disengage from fastener **830**. In some circumstances, this may be desired. In other cases, the anchoring shim **832** may be used when the blades **802** have already been opened.

FIGS. **8**L and **8**M depict yet another embodiment of an anchoring shim **836**, that also utilizes deflectable tabs **808** to selectively locate associated projections (not shown) within the ratcheted groove **804** (similar to the shims of FIGS. **8**A-**8**G). A single fastener retention hook **838** wraps at least partially around the fastener **830**. Accordingly, this anchoring shim **836** may provide more screw holding force than the embodiment depicted in FIGS. **8**J and **8**K. Regardless of the differences, use of each of the anchoring shims described herein may be desirable at different stages of a surgical procedure, depending on particular working conditions, clearance issues, or surgeon preferences.

Yet another anchoring shim **840** is depicted in FIG. **8**N. This anchoring shim **840** is similar in configuration to the anchoring shim **824** of FIGS. **8**H and **8**I, in that it may freely slide within the groove **804** of the blade **802**. Further, housing **826** has a channel or hole therethrough to receive the fastener **830**. Again, fastener **830** may be a threaded screw, a non-threaded screw, a pin, an elongate wire, or the like. Connected to the housing **826** is an elongate arm **842**. Arm **842** is coupled to the armature **844** to which the blade **802** is attached. In this manner, once the fastener **830** is anchored to the vertebral body, the blade **802** may be disconnected from the arm **844** and from the shim **840** and removed from the surgical corridor. This may occur, for example, by removing screw **612** holding the proximal end of blade **802** to armature **844**, and lifting the blade **802** vertically to disengage blade **802** from shim **840**. The elongate arm **842** allows the armature **844**, and thus the retractor, to remain secured to the anchoring shim **840**. Accordingly, access to the interior of the surgical corridor may be improved with the blade **802** removed therefrom.

In another embodiment, one or more of the retractor blades comprise telescoping blades. In such an embodiment, the retractor blade includes a proximal-most portion coupled to the retractor arm and a distal-most portion. The proximal-most portion and the distal-most portion overlap in a telescoping or nestled fashion to allow the retractor blade to have a variable overall length. In some embodiments, the telescoping blade components have a slidable relationship, but are non-separable, to ensure they stay connected while opening or holding the surgical corridor. In some embodiments, shims described herein have a boss, peg, or similar feature on the back of the shim which slides in a groove or slot in the blade to which it is coupled. The groove has a closed distal end that operates as a travel stop for the shim boss or the like. In this manner, the boss and groove combination, or similar structure, prevents the shim from sliding out the distal end of the blade.

FIGS. **9**A-**9**C depict a method of performing a surgical procedure with the systems and devices described herein. FIG. **9**A depicts a transverse cross-sectional view **900** of the torso **902** of a human body. For a lateral surgical procedure, the patient is positioned on a surgical table and x-rays, such as true lateral and anterior-posterior, may be taken. The surgeon may then make a first incision in the desired location. The initial distraction corridor (i.e., separation of the muscle fibers) is made using blunt dissection, as depicted in FIG. **9**A. Blunt dissection requires a surgeon to digitally penetrate the torso **902** with one or more fingers **904**. Using blunt dissection, a posteriorly-directed trajectory (aiming for the transverse process) is used to enter the retroperitoneal space **906**. Once the retroperitoneal space **906** has been entered, the tissue is distracted into the free space of the retroperitoneum. The peritoneum may be moved anterior with the fingers **904** and blunt dissection continued to palpate to the transverse process posteriorly. The finger **904** may be slid forward to the retro-psoas recess and over the dome of the psoas to ensure retroperitoneal viscera have been safely retracted anteriorly. In general, the distraction corridor is formed in a direction generally towards the spine **908**.

FIG. **9**B depicts an anterior view of a spine **908**. After the blunt dissection depicted in FIG. **9**A, a first dilator **910** is inserted through the incision. The location of the first dilator **910** may be verified using lateral fluoroscopy. It is desirable that the first dilator **910** be targeted to the center of the intervertebral disc space **912**. The first dilator **910** may be advanced through the psoas muscle (not shown) using a rotating motion. In some cases, the first dilator **910** may be located between about the center and about the posterior-third of the disc space **912**, and the position verified using lateral fluoroscopy. Once the first dilator **910** is an acceptable position, a K-wire **914** may be inserted through the center thereof and into the disc space **912**. The K-wire **914** may be inserted approximately half-way across the disc space **912** to assist in securing the access entry point. Again, anterior-posterior and lateral fluoroscopy may be used to ensure the proper location of the K-wire **914** and the first dilator **910**. Thereafter, a second dilator (not shown in FIG. **9**B) may be advanced over the first dilator **910**, using a rotating motion.

FIG. **9**C depicts a perspective view of a spine **908**. After insertion of the second dilator **916** over the first dilator **910**, the retractor blades **918** of the retractor device **920** are placed around the second dilator **916** and advanced downward into position. Position of the blades **918** may be verified as in-line with the disc space using fluoroscopy. It is generally desirable that the retractor **920** be parallel to the disc space **912** and the retractor working channel (the space between the blades **918**) be aligned with the disc space **912**. In some cases, such as when working around other bony structure (e.g., ribs, iliac crest, etc.), the retractor **920** may be angled in the cranial/caudal direction relative to the patient. The retractor **920** may next be secured in place by connecting an articulating arm (not shown) to one of the retractor connection points. The articulating arm is also connected to a generally fixed or stable structure, such as the surgical table, to provide a steady platform for retractor **920**.

The surgical corridor may now be expanded and otherwise altered as desired in accordance with the manipulations of the retractor device **920** described above. Typical functions include separation of the cranial/caudal blades, retrac-

tion of the posterior blade, toeing of the blades, etc. Once the retractor blades **918** are opened to the desired position, the first dilator **910**, the second dilator **916**, and the K-wire **914** may be removed. Once these components are removed, an implant insertion procedure may be performed. Any number of actions may be taken, in almost any order, to insert an implant. For example, an intradiscal shim (as depicted above), may be extended out of the posterior blade in which it is located during insertion and into the disc space **912**. The position of this element may be verified using anterior-posterior fluoroscopy. Additionally, widening or lengthening shims may be advanced as needed. If desired, the handle **922** may be removed from the retractor device **920**. Annulotomy and discectomy procedures may then be undertaken to remove the disc material, and an appropriately sized implant may be inserted. After implantation, the retractor blades **918** may be closed and removed from the body and the surgical corridor sutured closed.

FIG. **9**D depicts a perspective view of the retractor device **920** with the blades **918** in an open position. In this figure, the spine has been removed for clarity. As described elsewhere herein, rotation R of the main actuator **926** of the handle **922** opens the cranial and caudal arms **928**. Resistance of the patient tissue, however, may make difficult the rotation R of the main actuator **926** about the handle axis A. In that case, the posterior actuator **930** may be withdrawn from the handle **922** along the axis A. Thereafter, a tip of the posterior actuator **930** may be inserted into one of several torque points **932** about an outer diameter of the main actuator **926**. A torque T may be applied to the posterior actuator **930**, such that actuator **930***t* acts as a lever to make for easier rotation R of the main actuator **926**. Once the arms **928** have been opened to the desired position, the posterior actuator **930** may be returned to its original location on the handle **922**. As previously described, in some embodiments main actuator **926** operates a worm gear drive to allow blades **918** to be opened a desired amount and maintained.

FIG. **9**E depicts a perspective view of the retractor device **920** with the blades **918** in an open position. In this figure, the spine has been removed for clarity. Forces acting on the blades **918** by the body tissue may also cause the retractor device **920** to move undesirably. To overcome such forces, a pivot lever **934** may be connected to one of the arm connections **936** (that are typically used for connection to an articulating arm, as described above) and a torque T' applied. This will rotate R' the entire device **920** about the device axis A, thus improving the ability to position the device **920** as desired. This may be especially helpful when attempting to anchor any of the blades **918** to the vertebrae with the anchoring shims described above. Pivot lever **934** also may be used to rotate retractor **920** about the dilators to aid in the insertion of retractor **920** towards the surgical site, or provide a hand-hold for a user to better hold, support or manipulate retractor **920**.

FIG. **9**F depicts other components that may be utilized with the retractor device **920** to fix the position of the device **920** within the body and/or to create or maintain a desired operative opening. As shown, a span member **938** connects to the free ends of both of the articulating arms **928**. In some embodiments, the span **938** defines a slot **940** through which one or more anchor rods **942** may be passed. The anchor rods **942** may be screwed into vertebral bodies, typically on either side of a target disc **912**. In addition to fixing the position of the device **920** relative to the spine **908**, the anchor rods **942** may also be used to hold back tissue that may creep into the space between the cranial and caudal blades **918** once opened.

In an alternative embodiment, an additional or optional paddle **944** is provided to help create or maintain a desired operative window. For example, and as depicted in FIG. **9**G, paddle **944** may be coupled to a span **946** placed between the two pivoting arms (not depicted in FIG. **9**G) after the surgical access corridor is created. The span **946** may be similar or identical to the span **938** of FIG. **9**F. In general, the paddle **944** is positioned generally opposite the posterior blade, although it could be coupled to the span **938** at any location. In this manner, the paddle **946** helps maintain an additional side, such as an anterior side, of the surgical access corridor. The paddle may simply be a static blade or rod, or other elongate member having any cross-sectional profile. In the depicted embodiment, the paddle **944** includes an elongate rod **948** having a wider base **950**. Opposite the wider base **950** is a handle **952** that may be moved as desired to position the paddle **944**. A fastener member, shown as a threaded knob, operates to couple elongate rod **948** to the span **946**. The fastener member further may couple the elongate rod **948** to control the depth of paddle **944** relative to the surgical location. In most embodiments, the paddle **944** lacks any additional structure that would enable use thereof with shims. However, in alternative embodiments, such structure (grooves, etc.) may be incorporated if desired. Since the paddle **944** is generally used to prevent tissue creep from the space between the cranial and caudal blades, any type of rigid structure that can hold tissue is sufficient.

The methods depicted in FIGS. **9**A-**9**C may be modified by the incorporation of known neuromonitoring techniques. Neuromonitoring is not required to perform the procedures described herein, but may be desirable and is therefore incorporated at the surgeon's discretion. A number of different neuromonitoring systems may be utilized. Manufacturers of acceptable systems include Caldwell Laboratories, Inc., of Kennewick, Wash. Caldwell Laboratories, as well as other manufacturers, also manufactures monitoring probes (also referred to as electrodes) that may be utilized in conjunction with various surgical instruments or alone for treatment or diagnostic purposes. These electrodes are typically disposable elements that may be inserted into the body as required. The dilators described herein, as well as the retractor blades, include one or more channels to receive such probes. The probes may be inserted before or after insertion of the particular component into the body, again at the surgeon's discretion. Neuromonitoring techniques, in conjunction or discrete from surgical implements, are well-known to persons of skill in the art. Regardless, when electrodes are used in conjunction with the components described herein, the electrode is typically first inserted into the appropriate channel of the component. Once the component is inserted into the desired depth within the body, the neuromonitoring equipment is then activated and the response from the nerves detected. Proper operation of neuromonitoring equipment typically requires that the component first be inserted, stopped at a desired position, then neuromonitoring performed. This gives the surgeon the feedback necessary to adjust the position of the component so as to avoid the nerves. This may be performed in steps, advancing the component a certain distance, stopping advancement, monitoring, and repeating advancement as required.

FIGS. **10**A and **10**B depict a method **1000** of using a retractor system. Although the method is described in the context of lateral-approach spinal surgery, it should be noted that the systems and methods described herein may be used in virtually any surgery where limited muscular trauma is desired. In surgeries where limited, controlled separation of

muscle fibers is desirable, the retractor system described herein may be particularly advantageous. Although described in conjunction with FIGS. **10**A and **10**B, the order of steps or procedures may differ from that depicted. First, as previously depicted in FIG. **9**A, the patient is properly positioned and an incision is made in the desired location and the initial distraction corridor is formed via blunt (i.e., digital) dissection (operation **1002**). After the initial distraction corridor is formed, a first dilator is inserted (operation **1004**). Thereafter, a K-wire may be inserted via the lumen of the first dilator and secured to the disc space (operation **1006**). This helps prevent movement of the dilator, thus keeping that element (and the subsequent elements) properly positioned within the body. Thereafter, a second dilator is inserted over the first dilator (operation **1008**), such that the first dilator (and K-wire located therein) are located within the lumen of the second dilator. If desired, additional dilators may be used to create a larger corridor before insertion of the retractor. A retractor device is then inserted over the second dilator (operation **1010**). During insertion of the retractor device, the arms and blades of the device are in the closed position (that is, the position where each blade is located as close as possible to the two adjacent blades). Blades containing the intradiscal shim have a sufficiently low profile to allow for insertion of the retractor with the intradiscal shim. Further, the low profile of the intradiscal shim and the shim extension tool allows the shim to be advanced from a retracted position to an extended position after the retractor has been inserted and before the dilators have been removed. This helps secure the retractor with the intradiscal shim between two bony structures, such as vertebrae, before the dilator(s) and/or K wire is removed. Additionally, any blades that may have toeing functionality should be set such that the blades are parallel to the direction of insertion. During insertion, all three of the blades of the retractor device are inserted simultaneously.

Once the retractor device is inserted to the desired depth, the K-wire and dilators may be removed from the area between the blades (operation **1012**). To secure the retractor device at the desired location, an articulating arm connected to the surgical table or other fixed element may be connected to one of the connection points on the retractor device body or posterior arm (operation **1014**). In some embodiments, operation **1014** occurs prior to operation **1012**. In addition to the articulating arm, an intradiscal shim located within the posterior blade may also be extended into the disc space to further secure the device in the desired location. The operation of extending the intradiscal shim is described below. Once the retractor device is in the desired position, the cranial and caudal arms (and, therefore the cranial/caudal blades) may be expanded and the posterior blade retracted (operation **1016**). Once the various blades are expanded to the desired distance, a surgical procedure may be performed.

However, the retractor device described herein includes, or may be utilized with, a number of supplemental components to increase versatility of the device. This versatility allows a surgeon to modify the surgical corridor (operation **1018**) as required or desired to address particular internal anatomical conditions, or to otherwise improve usability of the retractor device. For example, and as noted first above, the intradiscal shim may be extended from its stored position in the posterior blade to further fix the position of the device relative to the spine (operation **1018***a*). Other shims may also be used in conjunction with the cranial and caudal blades. For example, the widening and/or lengthening shim may be used to supplement the blades. In some embodiments, the shims are loaded into their respective blades after the retractor blades have been inserted into the patient. This occurs, for example, by inserting the shim down through the proximal end (top) of the blade using a shim inserter tool. Alternatively, at least some of the shims have a sufficiently low profile to be inserted into the blades prior to insertion of the blades into the patient. As previously noted, there may be a small gap between one or more blades as the blades are inserted over the largest dilator. To use either of the widening or lengthening shims, the shim is placed into the shim groove in the desired blade, then advanced down towards the end of the blade (operation **1018***b*). The tab and groove interface of the shim and blade allows the shim to be advanced as far as required or desired, and resists or prevents undesired movement of the shim back towards the proximal end of the blade. The cranial and caudal blades may also be toed out to increase the area of the corridor proximate the spine (operation **1018***c*). If more robust fixation of the blades within the surgical corridor is desired, anchoring shims may be used to engage the vertebra (operation **1018***d*). Typically, the anchoring shims are inserted after the blades have been inserted into the patient and opened or separated at least enough to allow shim insertion. Alternatively or additionally, one or more rods may also be anchored (operation **1018***e*). Another modification of the corridor includes utilizing the supplemental paddle between the cranial and caudal arms to prevent tissue creep into the space therebetween (operation **1018***f*). Of course, any or all of these operations may be performed at any desired time to modify, enhance, or otherwise support the surgical corridor.

Regardless, once the desired corridor is obtained, an implant insertion procedure is performed (operation **1020**). The steps of the implant insertion procedure would be known to a person of skill in the art and are not described further. Once the implant insertion procedure is completed, shims and other optional features are retracted or removed. The retractor blades may be closed and the device removed from the body, allowing the surgeon to close the incision (operation **1022**). As described above, neuromonitoring may be utilized during any point of the method, at the discretion of the surgeon.

Materials utilized in the manufacture of the retractor system may be those typically used in surgical equipment. Stainless steel, titanium, and other robust metals that may be sterilized may be used. In applications where fluoroscopy is desirable or required during the procedure (e.g., in the spinal surgery procedures described herein), radio-lucent materials may be particularly desirable. In those applications, aluminum, anodized aluminum, and rigid polymers may be utilized. In some embodiments, the retractor blades comprise aluminum which has been anodized with a hard coat anodizing process to create an electrical insulated material. Such blades may be useful, for example, in the event the surgeon prefers to use electrical nerve monitoring equipment. Carbon fiber-reinforced polymers may be particular useful, as they are lightweight, extremely strong, and may be sterilized. Of course, retractor systems utilizing a combination of materials may be used. For example, radio-lucent materials may be used for the blades and less expensive radio-opaque material may be utilized for the elongate element and armatures. Use of radio-lucent materials for the cover plate, armatures, and body may be particularly advantageous, as an instrument so configured will be less visible in lateral x-rays. Additionally, radio-opaque materials may be impregnated in discrete locations of components manufactured of radio-lucent materials such that position of certain parts of the system may be visible during procedures, without impeding overall visibility.

While there have been described herein what are to be considered exemplary and preferred embodiments of the present technology, other modifications of the technology will become apparent to those skilled in the art from the teachings herein. The particular methods of manufacture and geometries disclosed herein are exemplary in nature and are not to be considered limiting. It is therefore desired to be secured in the appended claims all such modifications as fall within the spirit and scope of the technology. Accordingly, what is desired to be secured by Letters Patent is the technology as defined and differentiated in the following claims, and all equivalents.

What is claimed is:

1. A surgical retractor comprising:

a retractor body including a medial longitudinal axis;

a first armature including a first gear and a second armature including a second gear, each armature pivotably coupleable to the retractor body;

a first retractor blade affixed to a distal portion of the first armature;

a second retractor blade affixed to a distal portion of the second armature;

a translatable armature supported by the retractor body between the first and second armatures, the translatable armature linearly translatable to translate a third retractor blade affixed to a distal portion of the translatable armature;

a central drive internal to the body and engageable with both the first gear and the second gear;

a first actuator coupled to the drive, the first actuator operable to operate the drive to concurrently pivot the first armature and the second armature;

a second actuator operable to linearly translate the translatable armature; and

a first shim coupleable to a distal portion of the first retractor blade;

a second shim coupleable to a distal portion of the second retractor blade; and

a third shim coupleable to a distal portion of the third retractor blade.

2. The surgical retractor of claim **1**, wherein each shim is sized and configured to insert between two vertebrae during a spinal procedure.

3. The surgical retractor of claim **1**, wherein each shim further comprises a pair of tabs extending from a proximal portion of each shim; and

wherein each blade further comprises a plurality of pairs of grooves configured to receive the pair of tabs such that the pair of tabs can lockingly engage each pair of grooves.

4. The surgical retractor of claim **3**, wherein the plurality of grooves are angled to enable a ratcheting engagement between the plurality of grooves and the pair of tabs.

5. The surgical retractor of claim **3**, wherein each pair of tabs is cantilevered from a proximal termination of the shim allowing the pair of tabs to flex towards each other to disengage the grooves.

6. The surgical retractor of claim **1**, wherein the first armature and the second armature are movable independent of the translatable armature.

7. The surgical retractor of claim **1**, wherein the wherein the first actuator rotates the driver, wherein the driver directly interfaces with the first armature and the second armature.

8. An apparatus comprising:

a retractor body;

a first armature including a first gear, the first armature pivotably coupleable to the retractor body;

a second armature including a second gear, the second armature pivotably coupleable to the retractor body;

a retractor blade affixed to a distal portion of the first armature, the first armature pivotable to rotate the retractor blade;

a translatable armature supported by the retractor body between the first and second armatures, the translatable armature linearly translatable to translate a third retractor blade;

a central drive internal to the body and engageable with both the first gear and the second gear;

an actuator operable to pivot the first gear and the second gear;

a second actuator operable to linearly translate the translatable armature; and

a shim coupleable to a distal portion of the retractor blade, the shim further comprising a pair of tabs extending from a proximal portion of the shim, the tabs releasably securable to a pair of grooves of the retractor blade.

9. The surgical retractor of claim **8**, wherein the shim is sized and configured to insert between two vertebrae during a spinal procedure.

10. The surgical retractor of claim **8**, wherein the blade includes a plurality of pairs of grooves.

11. The surgical retractor of claim **10**, wherein each groove of the plurality of pairs of grooves is angled to enable a ratcheting engagement between the plurality of pairs of grooves and the pair of tabs.

12. The surgical retractor of claim **10**, wherein each pair of tabs is cantilevered from a proximal end of the shim allowing the pair of tabs to flex towards each other to disengage the grooves.

13. The surgical retractor of claim **8**, wherein the actuator rotates the driver and wherein the driver directly interfaces with the first and second gears.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 10,076,320 B2
APPLICATION NO. : 15/680744
DATED : September 18, 2018
INVENTOR(S) : Mast et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Column 16, Lines 8-9, in Claim 7, delete "wherein the wherein the" and insert --wherein the-- therefor

Signed and Sealed this
Twenty-fifth Day of June, 2019

Andrei Iancu
Director of the United States Patent and Trademark Office